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# AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES



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# Typical Report Citation and Abstract

- ① 19970001126 NASA Langley Research Center, Hampton, VA USA
- ② Water Tunnel Flow Visualization Study Through Poststall of 12 Novel Planform Shapes
- ③ Gatlin, Gregory M., NASA Langley Research Center, USA Neuhart, Dan H., Lockheed Engineering and Sciences Co., USA; Mar. 1996; 130p; In English
- Contract(s)/Grant(s): RTOP 505-68-70-04
- ④ Report Note(s): NASA-TM-4663; NAS 1.15.4663; L-17418; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche
- ⑤ To determine the flow field characteristics of 12 planform geometries, a flow visualization investigation was conducted in the Langley 16- by 24-Inch Water Tunnel. Concepts studied included flat plate representations of diamond wings, twin bodies, double wings, cutout wing configurations, and serrated forebodies. The off-surface flow patterns were identified by injecting colored dyes from the model surface into the free-stream flow. These dyes generally were injected so that the localized vortical flow patterns were visualized. Photographs were obtained for angles of attack ranging from 10° to 50°, and all investigations were conducted at a test section speed of 0.25 ft per sec. Results from the investigation indicate that the formation of strong vortices on highly swept forebodies can improve poststall lift characteristics; however, the asymmetric bursting of these vortices could produce substantial control problems. A wing cutout was found to significantly alter the position of the forebody vortex on the wing by shifting the vortex inboard. Serrated forebodies were found to effectively generate multiple vortices over the configuration. Vortices from 65° swept forebody serrations tended to roll together, while vortices from 40° swept serrations were more effective in generating additional lift caused by their more independent nature.
- ⑥ Author
- ⑦ Water Tunnel Tests; Flow Visualization; Flow Distribution; Free Flow; Planforms; Wing Profiles; Aerodynamic Configurations

## Key

1. Document ID Number; Corporate Source
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# AERONAUTICAL ENGINEERING

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*A Continuing Bibliography (Suppl. 409)*

NOVEMBER 1999

**01  
AERONAUTICS**

19990089689 Georgia Inst. of Tech., Aerospace Systems Design Lab., Atlanta, GA USA

Creation of a Technology Impact Forecasting Environment for an Intra-Continental Civil Aircraft. *Final Report, 1 Jan. 1996 - 31 Mar. 1998*

Mavris, Dimitri N., Georgia Inst. of Tech., USA; 1998; 87p; In English

Contract(s)/Grant(s): NAG2-1047; Copyright: Avail: CASI; A05, Hardcopy; A01, Microfiche

This presentation discusses the technology, and the challenges involved in creating a new intra-continental aircraft system. There are four possible designs for this system of aircraft: (1) the high-speed civil transport, (2) a large capacity subsonic transport, (3) blended wing-body high capacity transport, (4) intracontinental, conventional subsonic transport. Using the Fast Probability Integration (FPI) technique the researchers performed a Most Probable Point analysis to generate a cumulative distribution function for a given response function in each of the studied aircraft design models. This technique approximates Monte Carlo techniques in the design analysis and does so with significant savings in time and cost. The objective of this study was to arrive at evaluation criteria for assessing the success of a system design, which includes performance and economic design requirements and captures the needs of all pertinent parties and to arrive at metrics which would validate the success of the evaluation criteria. Using NASA Ames' point designs these were expanded into design spaces. Feasibility and viability assessments of the design spaces were performed. Using the 1997 baseline of technical feasibility, the application of new technologies in the design resulted in improvements as measured by the objective and constraints. Not all of the 2020 targets could be met. A proof of concept technology impact forecast environment was created which can identify the impact of proposed technologies for assessing the goal of affordability.

CASI

*Design Analysis; Economics; Forecasting; Systems Engineering; Technology Assessment*

19990091939 Royal Aeronautical Society, London, UK

The Aeronautical Journal, Volume 102

Stollery, John, Editor, Royal Aeronautical Society, UK; The Aeronautical Journal; Mar. 1998; ISSN 0001-9240; 71p; In English; See also 19990091940 through 19990091945; Copyright: Avail: Issuing Activity, Hardcopy

This issue of the Aeronautical Journal contains articles entitled: (1) Shockwaves in the rotor world - a personal perspective of 30 years of aerodynamic developments in the UK; (2) The effect of trailing edge geometry of trailing edge geometry on cavity flow oscillation driven by supersonic shear layer; (3) The influences on optimal structural designs of the modelling process and design concepts; (4) A generic control anticipation parameter for aircraft handling qualities evaluation; (5) A robust controller design for supersonic intermittent blowdown-type wind tunnels; (6) The effect of skewing on the vorticity produced by airjet vortex generator.

CASI

*Aircraft Control; Flight Characteristics; Structural Design; Aeronautics; Aeronautical Engineering; Civil Aviation; Rotor Aerodynamics; Military Aircraft*

19990091940 Royal Aircraft Establishment, Farnborough, UK

Shockwaves in the rotor world - A personal perspective of 30 years of rotor aerodynamic developments in the UK

Wilby, P. G., Royal Aircraft Establishment, UK; The Aeronautical Journal; Mar. 1998; Volume 102, No. 1013, pp. 113-128; In English; See also 19990091939; Copyright: Avail: Issuing Activity, Hardcopy

Tonight we commemorate the achievements of Juan de la Cierva, the great pioneer of rotary aviation. His development of the autogyro stimulated the development of the early rotor theories and paved the way for the modern helicopter. In turning the autogyro into a practical aircraft, Cierva proved to be an innovator prepared to take an unconventional approach. He was at the same time pragmatic in that he really wanted to build a helicopter but realised that the required technology was not yet mature, and settled on the autogyro as representing what was an achievable concept. His concept was thus unconventional, dramatic and achievable—an admirable combination. However, in his first attempts to fly an autogyro he rapidly came up against the problem that faces all rotary wing designers? which is that the advancing blade has a much greater lifting potential than the retreating blade, due to the difference in dynamic head. This led him to introduce the flapping hinge that allowed the rotor to achieve roll balance as well as providing the backward tilt of the rotor that is necessary for autorotation. Having made this step forward, he realised that the introduction of blade camber would allow the retreating blade to achieve higher angles of incidence before stalling, but in so doing he built in a potentially dangerous control characteristic. In this 38th Cierva Memorial Lecture, these issues of: (1) the balance of advancing and retreating blades; (2) the constraints over the introduction of camber; (3) the maturity - and exploitation - of associated technology and the willingness to take an unconventional route, are all key themes as I review the developments in rotor aerodynamics with which I have been associated over the past 30 years.

**Author**

*Aerodynamic Balance; Autogyros; Helicopters; Rotor Aerodynamics; Rotors; Camber; Aerodynamic Drag; Transonic Flow; Airfoils*

19990101884 Royal Aeronautical Society, London, UK

The Aeronautical Journal, Volume 102

Stollery, John, Editor, Royal Aeronautical Society, UK; The Aeronautical Journal Volume 102 Number 1011 January 1998; Jan. 1998; ISSN 0001-9240; 63p; In English; See also 19990101885 through 19990101891; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This issue contains a variety of articles about aeronautics, aircraft design, and other studies. The articles are titled: (1) Identification of non-linear derivative models from Bo 105 flight test data, (2) On the equations of motion for an aircraft with an internal moving load which is then dropped, (3) Two new techniques for aircraft parameter estimation using neural networks, (4) Variable cycle jet engines for a Mach 2.7 supersonic civil transport, (5) Experiments on cruise jet propulsion with a hydrogen scramjet, (6) Studies into hail ingestion of turbofan engines using a rotating fan and spinner assembly, and (7) Combined effect of wall suction and riblets on a low R(sub theta) turbulent boundary layer.

**CASI**

*Aircraft Design; Flight Tests; Aeronautics; Aeronautical Engineering; Aerodynamics; Avionics*

19990104600 Logistics Management Inst., McLean, VA USA

A System for Integrated Reliability and Safety Analyses *Final Report*

Kostiuk, Peter, Logistics Management Inst., USA; Shapiro, Gerald, Logistics Management Inst., USA; Hanson, Dave, Draper (Charles Stark) Lab., Inc., USA; Koltz, Stephan, Draper (Charles Stark) Lab., Inc., USA; Leong, Frank, Draper (Charles Stark) Lab., Inc., USA; Rosch, Gene, Draper (Charles Stark) Lab., Inc., USA; Coumeri, Marc, Draper (Charles Stark) Lab., Inc., USA; Scheidler, Peter, Jr., Draper (Charles Stark) Lab., Inc., USA; Bonesteel, Charles, CHAVA Group, USA; August 1999; 90p; In English

Contract(s)/Grant(s): NAS2-14361; RTOP 536-16-11-01

Report No.(s): NASA/CR-1999-209548; NS805S1; NAS 1.26:209548; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

We present an integrated reliability and aviation safety analysis tool. The reliability models for selected infrastructure components of the air traffic control system are described. The results of this model are used to evaluate the likelihood of seeing outcomes predicted by simulations with failures injected. We discuss the design of the simulation model, and the user interface to the integrated toolset.

**Author**

*Reliability Analysis; Aircraft Safety; Air Traffic Control; Computerized Simulation; Failure Modes; Systems Integration; Systems Analysis*

19990104603 Air Command and Staff Coll., Maxwell AFB, AL USA

Air Force Aircraft Maintenance Outsourcing and Privatization: A Bonanza or A Bust?

Mellott, Lionel S.; Apr. 1998; 43p; In English

Report No.(s): AD-A367210; ACSC-194-1998-04; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

The increased use of outsourcing and privatization (O&P) represents a fundamental change in how the USAF does business in fulfilling its role of ensuring the Nation's security. A decreasing USAF budget and manpower without corresponding decrease in operations tempo has forced the USAF to find innovative methods to accomplish its mission and save scarce dollars for modernization programs. The lengthy procurement process for major new weapon systems demand the Air Force invest now for modernization so a capable USAF will exist in the future. Properly executed O&P initiatives saves manpower and dollars, and enables the Air Force to focus its dwindling budget on supporting the warfighter. In Chapter 1, it explains the big picture of O&P, in Chapter 2 it covers the laws and rules guiding O&P while emphasizing aircraft maintenance. Then in Chapter 3 it discusses the A-76 study process in detail. In Chapter 4 it supplies the views articulated by various high-level studies and leaders. Next, in Chapter 5, it provides qualitative data from real world experiences with outsourcing of aircraft maintenance. Finally in Chapter 6 it submits the author's conclusions drawn from the material presented

DTIC

*Aircraft Maintenance; Military Aircraft*

19990105810 Naval Postgraduate School, Monterey, CA USA

Improving Naval Aviation Maintenance Quality Management Processes at the Organizational Maintenance Level: The Influences of the International Standards Organization (ISO) 9000 Quality Management System on the Naval Aviation Maintenance Program

Couch, Christopher J.; Decker, Duane L.; Jun. 1999; 251p; In English

Report No.(s): AD-A367296; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

This thesis examines the similarities and differences between the Naval Aviation Maintenance Program (NAMP) and International Standards Organization (ISO) 9000 quality management systems (QMS), discusses the difference in quality management discipline under ISO 9000 and under the NAMP, and describes what must be changed in the aviation organizational maintenance sections of the NAMP to make them consistent with the ISO 9000 QMS. The NAMP is Naval aviation's overall guiding document that outlines command, administrative, and management relationships, and assigns maintenance policy and procedure responsibilities to the respective individuals for management. ISO 9000 is a series of international standards establishing requirements and guidelines for maintaining an organization's quality system. An overview is provided of quality management (QM) procedures, policies, tools, and audits; the NAMP Quality Management System (QMS); the ISO 9000 QMS; and QMS implementation procedures. Next, process maps are described for QM documentation, policies, and procedures under both the NAMP and ISO 9000. Each is compared and contrasted. Then, QM training under the NAMP and ISO 9000 is described, and advantages and disadvantages of each are listed. ISO 9000 QMS implementation issues and performance metrics are discussed. Finally, recommended changes to NAMP QM procedures, processes, and policies are provided.

DTIC

*Navy; Aircraft Maintenance; Policies*

## 02 AERODYNAMICS

*Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.*

19990090019 NASA Dryden Flight Research Center, Edwards, CA USA

Estimated Benefits of Variable-Geometry Wing Camber Control for Transport Aircraft

Bolonkin, Alexander, National Academy of Sciences - National Research Council, USA; Gilyard, Glenn B., NASA Dryden Flight Research Center, USA; October 1999; 48p; In English

Contract(s)/Grant(s): RTOP 522-16-14-00-39

Report No.(s): NASA/TM-1999-206586; H-2368; NAS 1.15:206586; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Analytical benefits of variable-camber capability on subsonic transport aircraft are explored. Using aerodynamic performance models, including drag as a function of deflection angle for control surfaces of interest, optimal performance benefits of variable camber are calculated. Results demonstrate that if all wing trailing-edge surfaces are available for optimization, drag can be significantly reduced at most points within the flight envelope. The optimization approach developed and illustrated for flight uses variable camber for optimization of aerodynamic efficiency (maximizing the lift-to-drag ratio). Most transport aircraft have significant latent capability in this area. Wing camber control that can affect performance optimization for transport aircraft includes symmetric use of ailerons and flaps. In this paper, drag characteristics for aileron and flap deflections are computed based on analytical and wind-tunnel data. All calculations based on predictions for the subject aircraft and the optimal surface deflection

are obtained by simple interpolation for given conditions. An algorithm is also presented for computation of optimal surface deflection for given conditions. Benefits of variable camber for a transport configuration using a simple trailing-edge control surface system can approach more than 10 percent, especially for nonstandard flight conditions. In the cruise regime, the benefit is 1-3 percent.

**Author**

*Wing Camber; Wind Tunnel Tests; Transport Aircraft; Adaptive Control; Cambered Wings*

**19990091941 Southampton Univ., Dept. of Aeronautics and Astronautics, UK**

The effect of trailing edge geometry on cavity flow oscillation driven by a supersonic shear layer

Zhang, X., Southampton Univ., UK; Rona, A., Southampton Univ., UK; Edwards, J. A., Defence Research Agency, UK; The Aeronautical Journal; Mar. 1998; Volume 102, No. 1013, pp. 129-136; In English; See also 19990091939; Copyright; Avail: Issuing Activity, Hardcopy

A computational analysis is performed of self-sustained oscillatory flow over a cavity driven by a shear layer at Mach 1.5. The unsteady flow is studied through solutions of the Reynolds-averaged Navier-Stokes equations with turbulence modelled by a two-equation k-omega model. The trailing edge (face) of a baseline rectangular cavity is modified using wedge and ramp shapes to investigate means for the suppression and attenuation of the self-sustained oscillation. Through modification of the shear layer impingement, both wedge and ramp are effective in reducing the level of oscillation. The time averaged pressure (form) drag coefficient of the cavity is also reduced significantly. The main cause of the drag reduction is the elimination or reduction of the high pressure area near the downstream corner of the cavity due to the presence of a vortex. Two types of unsteady flow exist when a curved ramp is employed: 'regular' and 'random'. The use of a  $h = 0.6D$  ramp generates a random type pressure fluctuation with lower rms pressure compared with the  $h = 0.2D$  and  $0.4D$  ramps.

**Author**

*Cavity Flow; Impingement; Navier-Stokes Equation; Oscillating Flow; Reynolds Averaging; Self Oscillation; Computational Fluid Dynamics; Turbulent Flow; Drag Reduction; K-Omega Turbulence Model*

**19990092371 Allison Engine Co., Indianapolis, IN USA**

Follow-on Low Noise Fan Aerodynamic Study *Final Report*

Heidegger, Nathan J., Allison Engine Co., USA; Hall, Edward J., Allison Engine Co., USA; Delaney, Robert A., Allison Engine Co., USA; February 1999; 148p; In English

Contract(s)/Grant(s): NAS3-27394; RTOP 538-03-11

Report No.(s): NASAS/CR-1999-206599; E-11088; NAS 1.26:206599; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The focus of the project was to investigate the effects of turbulence models on the prediction of rotor wake structures. The Advanced Ducted Propfan Analysis (ADPAC) code was modified through the incorporation of the Spalart-Allmaras one-equation turbulence model. Suitable test cases were solved numerically using ADPAC employing the Spalart-Allmaras turbulence model and another prediction code for comparison. A near-wall spacing study was also completed to determine the adequate spacing of the first computational cell off the wall. Solutions were also collected using two versions of the algebraic Baldwin-Lomax turbulence model in ADPAC. The effects of the turbulence model on the rotor wake definition was examined by obtaining ADPAC solutions for the Low Noise Fan rotor-only steady-flow case using the standard algebraic Baldwin-Lomax turbulence model, a modified version of the Baldwin-Lomax turbulence model and the one-equation Spalart-Allmaras turbulence model. The results from the three different turbulence modeling techniques were compared with each other and the available experimental data. These results include overall rotor performance, spanwise exit profiles, and contours of axial velocity taken along constant axial locations and along blade-to-blade surfaces. Wake characterizations were also performed on the experimental and ADPAC predicted results including the definition of a wake correlation function. Correlations were evaluated for wake width and wake depth. Similarity profiles of the wake shape were also compared between all numerical solutions and experimental data.

**Derived from text**

*Turbulence Models; Wakes; Computerized Simulation; Rotor Blades (Turbomachinery); Applications Programs (Computers); Program Verification (Computers); Rotor Dynamics; Rotor Aerodynamics*

**19990094230 Lockheed Martin Engineering and Science Services, Hampton, VA USA**

Development, Analysis and Testing of the High Speed Research Flexible Semispan Model

Schuster, David M., Lockheed Martin Engineering and Science Services, USA; Spain, Charles V., Lockheed Martin Engineering and Science Services, USA; Turnock, David L., Lockheed Martin Engineering and Science Services, USA; Rausch, Russ D., NASA Langley Research Center, USA; Hamouda, M-Nabil, Lockheed Martin Engineering and Science Services, USA; Vogler,

William A., Lockheed Martin Engineering and Science Services, USA; Stockwell, Alan E., Lockheed Martin Engineering and Science Services, USA; September 1999; 123p; In English

Contract(s)/Grant(s): NAS1-96014; RTOP 537-06-36-20

Report No.(s): NASA/CR-1999-209556; NAS 1.26:209556; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

This report presents the work performed by Lockheed Martin Engineering and Sciences (LMES) in support of the High Speed Research (HSR) Flexible Semispan Model (FSM) wind-tunnel test. The test was conducted in order to assess the aerodynamic and aeroelastic character of a flexible high speed civil transport wing. Data was acquired for the purpose of code validation and trend evaluation for this type of wing. The report describes a number of activities in preparing for and conducting the wind-tunnel test. These included coordination of the design and fabrication, development of analytical models, analysis/hardware correlation, performance of laboratory tests, monitoring of model safety issues, and wind-tunnel data acquisition and reduction. Descriptions and relevant evaluations associated with the pretest data are given in sections 1 through 6, followed by pre- and post-test flutter analysis in section 7, and the results of the aerodynamics/loads test in section 8. Finally, section 9 provides some recommendations based on lessons learned throughout the FSM program.

Author

*Semispan Models; Aircraft Models; Wind Tunnel Models; Wind Tunnel Tests; Data Acquisition; Data Reduction; Aerodynamics; Aeroelasticity*

19990095059 Norwegian Defence Research Establishment, Kjeller, Norway

Numerical Calculation of the Aerodynamic Heating of a Multipurpose Projectile

Venas, Bard, Norwegian Defence Research Establishment, Norway; Moxnes, John E., Norwegian Defence Research Establishment, Norway; Aug. 10, 1999; 30p; In English; Original contains color illustrations

Contract(s)/Grant(s): FFIBM Proj. 778/130

Report No.(s): FFI/RAPPORT-99/03963; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The report investigates the aerodynamic heating of a 25 mm multipurpose supersonic projectile, by means of a numerical analysis using the FLUENT (RAMPANT) code. The analysis shows that the steady state heating of the projectile nose tip is -300 K in the case of a laminar boundary layer. It is argued that the terminal temperature will be roughly the same in the case of a turbulent boundary layer. The main difference between the two situations will be that the heating will take place much more rapidly for a turbulent boundary layer, due to the higher convection rate. Some aspects of the laminar to turbulent boundary layer transition, and the effect this has on the heat transfer, are discussed.

Author

*Numerical Analysis; Aerodynamic Heating; Research; Turbulent Boundary Layer; Heat Transfer*

19990097285 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Stromungsmechanik, Goettingen, Germany  
Vortical Flow Structures at a Helicopter Rotor Model Measured by LDV and PIV

Raffel, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Seelhorst, U., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Willert, C., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; The Aeronautical Journal; Apr. 1998; ISSN 0001-9240; Volume 102, No. 1014, pp. 221-227; In English; 22nd; Rotorcraft, Sep. 1996, Brighton, UK

Report No.(s): Paper-2227; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

Flowfield measurements of the blade tip vortices from a rotating helicopter rotor model were performed by three component laser-Doppler velocimetry (3D-LDV) and conventional (two component) particle image velocimetry (PIV). In general, the results are in good correspondence, but also illustrate the different properties of both techniques: LDV offers the capability of three-component measurements, whereas PIV captures the unsteadiness of the flowfield.

Author

*Vortices; Particle Image Velocimetry; Flow Distribution*

19990098455 NASA Marshall Space Flight Center, Huntsville, AL USA

Aerodynamic Properties Analysis of Rapid Prototyped Models Versus Conventional Machined Models

Springer, A., NASA Marshall Space Flight Center, USA; Cooper, K., NASA Marshall Space Flight Center, USA; 1998; 1p; In English; Time Compression Technologies, 11-14 Oct. 1998, Nottingham, UK; No Copyright; Avail: Issuing Activity; Abstract Only

Initial studies of the aerodynamic characteristics of proposed launch vehicles can be made more accurately if lower cost, high fidelity aerodynamic models are available for wind tunnel testing early in the design phase. This paper discusses the results of a study undertaken at NASA's Marshall Space Flight Center to determine if four rapid prototyping methods using a variety of

materials are suitable for the design and manufacturing of high speed wind tunnel models in direct testing applications. It also gives an analysis of whether these materials and processes are of sufficient strength and fidelity to withstand the testing environment. In addition to test data, costs and turn-around times for the various models are given. Based on the results of this study, it can be concluded that rapid prototyping models show promise in limited direct application for preliminary aerodynamic development studies at subsonic, transonic, and supersonic speeds.

Author

*Aerodynamic Characteristics; Cost Analysis; Cost Reduction; Prototypes; Wind Tunnel Models*

19990100643 Lockheed Martin Engineering and Sciences Co., Hampton, VA USA

An Inviscid Computational Study of an X-33 Configuration at Hypersonic Speeds

Prabhu, Ramadas K., Lockheed Martin Engineering and Sciences Co., USA; July 1999; 26p; In English

Contract(s)/Grant(s): NAS1-96014; RTOP 242-80-01-01

Report No.(s): NASA/CR-1999-209366; NAS 1.26:209366; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report documents the results of a study conducted to compute the inviscid longitudinal aerodynamic characteristics of a simplified X-33 configuration. The major components of the X-33 vehicle, namely the body, the canted fin, the vertical fin, and the body-flap, were simulated in the CFD (Computational Fluid Dynamic) model. The rear-ward facing surfaces at the base including the aerospike engine surfaces were not simulated. The FELISA software package consisting of an unstructured surface and volume grid generator and two inviscid flow solvers was used for this study. Computations were made for Mach 4.96, 6.0, and 10.0 with perfect gas air option, and for Mach 10 with equilibrium air option with flow condition of a typical point on the X-33 flight trajectory. Computations were also made with CF4 gas option at Mach 6.0 to simulate the CF4 tunnel flow condition. An angle of attack range of 12 to 48 deg was covered. The CFD results were compared with available wind tunnel data. Comparison was good at low angles of attack; at higher angles of attack (beyond 25 deg) some differences were found in the pitching moment. These differences progressively increased with increase in angle of attack, and are attributed to the viscous effects. However, the computed results showed the trends exhibited by the wind tunnel data.

Author

*Computational Fluid Dynamics; Inviscid Flow; Viscous Flow; Unstructured Grids (Mathematics); X-33 Reusable Launch Vehicle; Venturestar Launch Vehicle; Aerospike Engines*

19990100650 NASA Langley Research Center, Hampton, VA USA

Static Performance of a Fixed-Geometry Exhaust Nozzle Incorporating Porous Cavities for Shock-Boundary Layer Interaction Control

Asbury, Scott C., NASA Langley Research Center, USA; Hunter, Craig A., NASA Langley Research Center, USA; August 1999; 139p; In English

Contract(s)/Grant(s): RTOP 538-14-12-01

Report No.(s): NASA/TM-1999-209513; NAS 1.15:209513; L-17879; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

An investigation was conducted in the model preparation area of the Langley 16-Foot Transonic Tunnel to determine the internal performance of a fixed-geometry exhaust nozzle incorporating porous cavities for shock-boundary layer interaction control. Testing was conducted at static conditions using a sub-scale nozzle model with one baseline and 27 porous configurations. For the porous configurations, the effects of percent open porosity, hole diameter, and cavity depth were determined. All tests were conducted with no external flow at nozzle pressure ratios from 1.25 to approximately 9.50. Results indicate that baseline nozzle performance was dominated by unstable, shock-induced, boundary-layer separation at over-expanded conditions. Porous configurations were capable of controlling off-design separation in the nozzle by either alleviating separation or encouraging stable separation of the exhaust flow. The ability of the porous nozzle concept to alternately alleviate separation or encourage stable separation of exhaust flow through shock-boundary layer interaction control offers tremendous off-design performance benefits for fixed-geometry nozzle installations. In addition, the ability to encourage separation on one divergent flap while alleviating it on the other makes it possible to generate thrust vectoring using a fixed-geometry nozzle.

Author

*Exhaust Nozzles; Porosity; Hole Geometry (Mechanics); Cavities; Thrust Vector Control*

19990102866 NASA Marshall Space Flight Center, Huntsville, AL USA

A Collaborative Analysis Tool for Integrating Hypersonic Aerodynamics, Thermal Protection Systems, and RBCC Engine Performance for Single Stage to Orbit Vehicles

Stanley, Thomas Troy, International Space Systems, Inc., USA; Alexander, Reginald, NASA Marshall Space Flight Center, USA;

1999; In English; Space Planes and Hypersonic Systems and Technologies, 4-9 Nov. 1999, Norfolk, VA, USA; Sponsored by American Inst. of Aeronautics and Astronautics; Copyright: Avail: Issuing Activity, Hardcopy; Abstract Only

Presented is a computer-based tool that connects several disciplines that are needed in the complex and integrated design of high performance reusable single stage to orbit (SSTO) vehicles. Every system is linked to every other system, as is the case of SSTO vehicles with air breathing propulsion, which is currently being studied by NASA. The deficiencies in the scramjet powered concept led to a revival of interest in Rocket-Based Combined-Cycle (RBCC) propulsion systems. An RBCC propulsion system integrates airbreathing and rocket propulsion into a single engine assembly enclosed within a cowl or duct. A typical RBCC propulsion system operates as a ducted rocket up to approximately Mach 3. At this point the transitions to a ramjet mode for supersonic-to-hypersonic acceleration. Around Mach 8 the engine transitions to a scramjet mode. During the ramjet and scramjet modes, the integral rockets operate as fuel injectors. Around Mach 10-12 (the actual value depends on vehicle and mission requirements), the inlet is physically closed and the engine transitions to an integral rocket mode for orbit insertion. A common feature of RBCC propelled vehicles is the high degree of integration between the propulsion system and airframe. At high speeds the vehicle forebody is fundamentally part of the engine inlet, providing a compression surface for air flowing into the engine. The compressed air is mixed with fuel and burned. The combusted mixture must be expanded to an area larger than the incoming stream to provide thrust. Since a conventional nozzle would be too large, the entire lower after body of the vehicle is used as an expansion surface. Because of the high external temperatures seen during atmospheric flight, the design of an airbreathing SSTO vehicle requires delicate tradeoffs between engine design, vehicle shape, and thermal protection system (TPS) sizing in order to produce an optimum system in terms of weight (and cost) and maximum performance.

Derived from text

*Hypersonic Speed; Aerodynamics; Thermal Protection; Launch Vehicles; Computer Techniques; Ducted Rocket Engines; Propulsion System Performance; Ramjet Engines; Single Stage to Orbit Vehicles*

19990102884 Lembaga Penerbangan dan Antariksa Nasional, Jakarta, Indonesia

Analysis of Aerodynamic Characteristics of 150mm Diameter Ballistic Rocket *Analisa Karakteristik Aerodinamika Roket Balistik Penjaga Selat*

Ginting, Salam, Lembaga Penerbangan dan Antariksa Nasional, Indonesia; Majalah LAPAN; January 1999; ISSN 0126-0480; Volume 1, No. 1, pp. 7-20; In Malay-Indonesian; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This paper presents the analysis on the aerodynamic characteristics of a 150 mm diameter ballistic rocket. The rocket is intended to be used in a tactical strait defense. The methods used in the analysis are mostly from the N.F. Krasnov aerodynamic theory since the book focuses on the specific rocket technology. The obtained aerodynamic characteristics are shown in the form of lift, drag, and moment curves. The aerodynamic coefficient data was used as an input to predict the static stability of the rocket in subsonic and supersonic speed. The data also used in designing the rocket trajectory and range, so that the rocket will be effective as a weapon in defending strait. As a comparison and to validate the calculation, the data from similar rocket which has been tested in Indonesia and abroad are also presented.

Author

*Rocket Vehicles; Aerodynamic Drag; Lift; Ballistics*

19990103968 NASA Lewis Research Center, Cleveland, OH USA

Vortex/Body Interaction and Sound Generation in Low-Speed Flow

Kao, Hsiao C., NASA Lewis Research Center, USA; September 1998; 36p; In English

Contract(s)/Grant(s): RTOP 522-31-23

Report No.(s): NASA/TM-1998-208403; NAS 1.15:208403; E-11235; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The problem of sound generation by vortices interacting with an arbitrary body in a low-speed flow has been investigated by the method of matched asymptotic expansions. For the purpose of this report, it is convenient to divide the problem into three parts. In the first part the mechanism of the vortex/body interaction, which is essentially the inner solution in the inner region, is examined. The trajectories for a system of vortices rotating about their centroid are found to undergo enormous changes after interaction; from this, some interesting properties emerged. In the second part, the problem is formulated. The outer solution is found, matching is implemented, and solutions for acoustic pressure are obtained. In the third part, Fourier integrals are evaluated and predicated results presented. An examination of these results reveals the following: (a) the background noise can be either augmented or attenuated by a body after interaction, (b) sound generated by vortex/body interaction obeys a scaling factor, (C) sound intensity can be reduced substantially by positioning the vortex system in the "favorable" side of the body instead of the

"unfavorable" side, and (d) acoustic radiation from vortex/bluff-body interaction is less than that from vortex/airfoil interaction under most circumstances.

Author

*Vortices; Sound Generators; Background Noise*

19990104599 Lockheed Martin Engineering and Sciences Co., Hampton, VA USA

Transonic Dynamics Tunnel Force and Pressure Data Acquired on the HSR Rigid Semispan Model

Schuster, David M., Lockheed Martin Engineering and Sciences Co., USA; Rausch, Russ D., Lockheed Martin Engineering and Sciences Co., USA; September 1999; 50p; In English

Contract(s)/Grant(s): NAS1-96014; RTOP 537-06-36

Report No.(s): NASA/CR-1999-209555; NAS 1.26:209555; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report describes the aerodynamic data acquired on the High Speed Research Rigid Semispan Model (HSR-RSM) during NASA Langley Transonic Dynamics Tunnel (TDT) Test 520 conducted from 18 March to 4 April, 1996. The purpose of this test was to assess the aerodynamic character of a rigid high speed civil transport wing. The wing was fitted with a single trailing edge control surface which was both steadily deflected and oscillated during the test to investigate the response of the aerodynamic data to steady and unsteady control motion. Angle-of-attack and control surface deflection polars at subsonic, transonic and low-supersonic Mach numbers were obtained in the tunnel's heavy gas configuration. Unsteady pressure and steady loads data were acquired on the wing, while steady pressures were measured on the fuselage. These data were reduced using a variety of methods, programs and computer systems. The reduced data was ultimately compiled onto a CD-ROM volume which was distributed to HSR industry team members in July, 1996. This report documents the methods used to acquire and reduce the data, and provides an assessment of the quality, repeatability, and overall character of the aerodynamic data measured during this test.

Author

*Transonic Wind Tunnels; Dynamic Tests; Semispan Models; Data Reduction; Aerodynamics; Supersonic Transports*

### 03 AIR TRANSPORTATION AND SAFETY

*Includes passenger and cargo air transport operations, and aircraft accidents.*

19990088763 Federal Data Corp., Science and Engineering Div., Egg Harbor, NJ USA

Validating the Computer-Based Training Process for Aviation Security Screeners

Fobes, J. L.; Neiderman, E. C.; Mar. 1999; 30p; In English

Report No.(s): PB99-149585; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

Test performance data from Safe Passage's Computer-Based Training (CBT) system for aviation security screeners were used to evaluate multiple choice content and X-ray image interpretation mastery test items to assess initial screener training. Data from 8,366 CBT tests were used from 691 screeners at 3 different sites. Test questions were evaluated for readability, item-to-test correlations, error rates, quality of response options, relevance to job requirements, training content reliability, adverse impact due to race and gender, and validity. Implication of these results for the design of the Screener Readiness Test and the evaluation of the new CBT systems is discussed.

NTIS

*Airport Security; Proving; Computer Assisted Instruction; Display Devices*

19990088769 Federal Aviation Administration, Aviation Security Human Factors Program, Atlantic City, NJ USA

Test and Evaluation Plan for Determining Screener Training Effectiveness

Klock, B. A.; Fobes, J. L.; Apr. 1999; 20p; In English

Report No.(s): PB99-149692; DOT/FAA/AR-99/42; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

The efficacy of Computer-Based Training (CBT) programs potentially useful for security checkpoint screener training will be evaluated at three different airports. Candidates will be trained with one of four CBT programs and the Screener Readiness Test, designed to assess screening-related knowledge, will then be used to evaluate the effectiveness of the CBT programs.

NTIS

*Airport Security; Computer Assisted Instruction; Display Devices*

1999089233 Department of Defense, Office of Inspector General, Arlington, VA USA

Audit Report: Hazardous Material Management for the C/KC-135 Stratotanker Aircraft

Jun. 04, 1999; 28p; In English

Contract(s)/Grant(s): Proj-8AE-5037.01

Report No.(s): AD-A366439; IG/DOD-TR-99-177; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

The C/KC-135 Stratotanker Aircraft (the C/KC-135) is an Air Force program that consists of Acquisition Category II and III modification programs. The principal mission of the C/KC-135 aircraft is aerial refueling of other aircraft. The Air Force acquired 808 stratotankers and other variants of the C/KC-135 aircraft, of which 548 stratotankers and 46 special-purpose variants are on active duty. The average age of the aircraft in the fleet is 39 years. The stratotankers are equipped with a flying boom for fuel transfer and a deck above the fuselage-mounted tanks for passengers and cargo. Eight Air Force major commands, the National Aeronautics and Space Administration, and three foreign militaries operate C/KC-135 aircraft. The Air Force plans to operate the stratotanker fleet until 2040 and estimates that the total life-cycle cost to continue the program until then will be about \$76 billion.

DTIC

*Hazardous Materials; Air to Air Refueling; Attack Aircraft; Decontamination; Environmental Monitoring*

1999089249 General Accounting Office, Resources, Community and Economic Development Div., Washington, DC USA

Aviation Competition: Information on the Department of Transportation's Proposed Policy

Anderson, John H., Jr.; Barbee, Janet; Jul. 1999; 21p; In English

Report No.(s): AD-A366145; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

GAO provided information on the proposed policy to facilitate DOT's review of the final policy. DOT decided to develop its proposed policy statement after receiving 17 complaints from new entrant airlines alleging that major airlines were unfairly lowering their fares, increasing capacity on certain routes, or both; investigating two of those complaints; and analyzing industrywide data concerning pricing and capacity activities by major airlines. DOT's investigations and analyses indicated possible unfair competitive practices by at least five major airlines. DOT concluded that the best approach for addressing its concerns about this conduct was to issue policy guidance on what, in its view, constituted unfair competitive practices warranting departmental action. DOT did not intend for the policy to discourage major airlines from competing against new entrants; rather, it wanted to prevent extreme behavior that was intended to drive a new entrant from a market. By issuing the proposed policy, DOT expected to initiate a national debate on the issues surrounding unfair competition. In addition, DOT officials believed that this approach would help with future enforcement regarding unfair competitive practices by major airlines in response to new low-fare airlines.

DTIC

*Airline Operations; Commercial Aircraft; Policies; Economics*

1999089250 General Accounting Office, Resources, Community and Economic Development Div., Washington, DC USA

Aviation Safety: FAA's New Inspection System Offers Promise, but Problems Need to Be Addressed

Jun. 1999; 41p; In English; Report to the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives.

Report No.(s): AD-A366144; GAO/RCED-99-183; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The aviation industry has forecast a potential 66-percent increase in passenger travel from 1999 to 2008. The U.S. aviation accident rate, which has remained relatively constant over the past two decades, must be substantially lowered to avoid escalating numbers of aviation deaths as air traffic increases. A key to reducing the aviation accident rate is for the Federal Aviation Administration (FAA) to have an effective process for inspecting the nation's airline operations. In the past, we and others have expressed concerns about the adequacy of FAA's inspection process to meet that challenge. Concerns about the inspection process focused on unstructured, nonsystematic inspections that produced few reports of safety problems and on the adequacy of inspectors' technical training. These concerns also raised questions about the quality and consistency of the resulting inspection data and their usefulness for conducting analyses and targeting FAA's resources to the greatest safety risks. FAA has responded to these concerns by redesigning the safety inspection system that it uses to oversee the nation's airlines. FAA began using the revised approach, called the Air Transportation Oversight System (ATOS), for a limited number of airlines during the system's initial implementation on October 1, 1998. Currently, the nation's 10 largest passenger airlines are under ATOS. At your request, we reviewed FAA's implementation of the new system.

DTIC

*Inspection; Aircraft Accidents; Airline Operations; Air Transportation; Air Traffic; Safety Factors*

19990092817 National Research Council of Canada, Flight Research Lab., Ottawa, Ontario Canada

Enhanced and Synthetic Vision System Concept for Application to Search and Rescue Missions

Swail, Carl, National Research Council of Canada, Canada; Jennings, Sion, National Research Council of Canada, Canada; Sensor Data Fusion and Integration of the Human Element; February 1999, pp. 15-1 - 15-6; In English; See also 19990092805; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Flight Research Laboratory of the National Research Council (NRC) in cooperation with the Department of National Defense and industrial collaborators, Canadian Marconi Company, and CAE electronics LTD is working to integrate new cockpit technologies to improve mission effectiveness and system safety of Search and REscue (SAR) missions conducted from helicopters. Search and Rescue aircraft operate in a demanding environment, often in remote areas, at night or in inclement weather. Cockpit systems that reduce pilot workload and improve pilot situational awareness can save lives when appropriately integrated into the aircraft. NRC and partners are building an enhanced and synthetic vision system (ESVS) to help SAR helicopter pilots complete their missions in degraded visual environments. The ESVS will provide SAR pilots with a real time display that mimics visual flight rules conditions. NRC plans to integrate and evaluate a prototype system by the year 2000. The prototype system will include a visually coupled helmet mounted display (HMD) system, a synthetic image generated from a terrain database, an advanced sensor and an image fusion system. A complementary research program is underway at NRC to investigate fundamental human-machine interface issues relevant to the proposed prototype system.

Author

*Display Devices; Enhanced Vision; Helmet Mounted Displays; Man Machine Systems; Night; Rescue Operations; Pilot Support Systems*

19990094059 Civil Aeromedical Inst., Oklahoma City, OK USA

Follow-up Assessment of the Federal Aviation Administration's Logistics Center Safety Climate *Final Report*

Behn, Lydia D., Civil Aeromedical Inst., USA; Thompson, Richard C., Civil Aeromedical Inst., USA; Hilton, Thomas F., Civil Aeromedical Inst., USA; June 1999, 26p; In English

Report No.(s): DOT/FAA/AM-99/19; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This report details Federal Aviation Administration (FAA) Logistics Center employee safety perceptions following the implementation of a safety awareness program. Safety perceptions were baselined in 1992 and a follow-up assessment was conducted in 1995. The purpose of the follow-up survey was to (1) assess differences in perceptions of safety that may have resulted from changes made in the safety program since the 1992 assessment; and (2) determine the managerial and organizational factors that may have impacted those safety perceptions. The present survey was administered to 329 employees (supervisors and non-supervisors) during a mandatory monthly safety meeting. The results show that specific actions intended to demonstrate the importance of safety can lead to higher levels of perceived management and supervisory support for safety. Such practices can also lead to higher levels of perceived safety in the workplace. These practices, however, do not appear to influence perceptions of organizational politics, supervisory fairness, or coworker support for safety.

Derived from text

*Logistics; Surveys; Aircraft Safety; Flight Safety; Safety Management*

19990094903 Army Safety Center, Fort Rucker, AL USA

Flightfax: Volume 27, No. 1, January 1999, The Cold Hardfacts

Jan. 1999; 12p; In English

Report No.(s): AD-A364839; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

We Americans, more than any other group, depend heavily on ice for our creature comforts. If you don't believe it, try serving us a warm soda. But as fond as we are of ice, even in our water (to the amazement of Europeans), one place nobody wants it is on an aircraft. You don't have to know a lot about aerodynamics to know that an aircraft weighted down with ice isn't going to fly very well. The more we know about where icing occurs and how it affects aircraft, the better equipped we'll be to avoid conditions where icing is a hazard.

DTIC

*Aircraft Icing; Aircraft Safety; Aircraft Hazards; Cold Weather*

19990097557 Department of Defense, Office of the Inspector General, Arlington, VA USA

Hazardous Material Management for the T-45 Undergraduate Jet Pilot Training System

Jul. 21, 1999; 44p; In English

Report No.(s): AD-A366328; DoD-IG-99-221; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

The T-45 Undergraduate Jet Pilot Training System (the T-45TS), an Acquisition Category IC program, is a Navy program designed to provide the necessary tools to train carrier and strike aviators for the Navy and Marine Corps. The T-45TS consists of T-45A/C aircraft with supporting ground equipment, contractor maintenance, and a pilot training integration system that incorporates classroom academics, sophisticated flight simulators, and a training support center. The T-45TS supports a pilot training rate of 361 pilots per year. In FY 1995, the T-45TS began full-rate production. The Program Office plans to acquire a total of 234 aircraft by FY 2005 and estimated life-cycle costs for the T-45TS Program to total about \$15.4 billion. Objectives. The Joint Logistics Commanders requested an audit of hazardous material management for major Defense systems. The T-45TS is one of nine programs included in the audit. The overall audit objective was to evaluate the adequacy of planning and providing for the reduction and control of hazardous materials used in the design, manufacture, maintenance, and disposal for the T-45TS. Specifically, we evaluated whether the program manager managed the selection, use, and disposal of hazardous materials so that DoD would incur the lowest cost required to protect human health and the environment over the system's life cycle that is consistent with the system's cost, schedule, and performance goals. We also evaluated the management control program as it related to the audit objective.

DTIC

*Hazardous Materials; Pilot Training; Aircraft Pilots; Management Planning*

19990099349 Nebraska Univ., Aviation Inst., Omaha, NE USA

The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG), Volume 3

Reynolds-Feighan, Aisling, Editor, University Coll., Ireland; Bowen, Brent D., Editor, Nebraska Univ., USA; The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG); December 1998; 232p; In English, 19-21 Jul. 1998, Dublin, UK; Sponsored by World Conference on Transportation Research Society

Contract(s)/Grant(s): NAGw-4414

Report No.(s): UNOAI-98-5; Copyright Waived; Avail: CASI; A11, Hardcopy; A03, Microfiche

Contents include the following: airline deregulation in Australia: a medium term assessment; why can't Japan deregulate the airline industry and open the sky immediately?; toward a market-oriented air transport system?; present developments in Russian civil aviation performance and policy; the asian economic crisis and its implications for aviation policy in asia pacific: industry outlook approaching the next millennium; a tale of two airlines: the post privatization performance of two caribbean airlines: the role of capital productivity in British Airways' financial recovery; airline privatization: does it matter?; airfright demand: responding to new developments in logistics; and air cargo business relationships.

CASI

*Conferences; Productivity; Policies; Logistics; Airline Operations; Air Cargo*

19990099350 Monash Univ., Clayton, Australia

Airline Deregulation in Australia: A Medium Term Assessment

Forsyth, Peter, Monash Univ., Australia; The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG); December 1998; Volume 3; 15p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In 1990, Australia deregulated its domestic air transport. Prior to deregulation there had been two trunk airlines which had been subjected to tight regulation, though there had been some liberalisation during the 1980s. International comparisons of costs and productivity suggested that there was considerable scope for efficiency improvement, and that deregulation would provide the impetus for substantial productivity growth. The early deregulation period saw two serious attempts at entry, but both of these failed, leaving the same two airlines dominating the market. Early studies have suggested some moderate, though certainly not large, productivity gains since deregulation; since these were done, there have not been major changes. Available evidence in recent years is evaluated to determine how performance has changed over the post deregulation period, and how it compares to performance overseas, for example, in North America. Analysis is made more difficult by reductions in data availability since deregulation. Emphasis is given to changes in productive efficiency, since this is likely to be the main source of welfare gain, though other changes are also considered. The paper assesses whether the expected gains have been achieved. The paper concludes with an interpretation of the results. The relatively modest improvement, coupled with a remaining gap in performance compared with overseas, raises the issue of whether competition between two dominant airlines is sufficiently strong to ensure minimum cost production. If so, there may be a lesson in this for other small to medium sized airline markets. Another explanation of the results may lie with the airline labor market; unlike what happened after US deregulation, there has been little change in airline labor markets, and possibly Australian labor market arrangements are hindering the achievement of overseas levels of productivity.

Author

*Market Research; Cost Effectiveness; Commercial Aircraft; Airline Operations; Regulations*

19990099351 Doshisha Univ., Kyoto, Japan

Why Can't Japan Deregulate the Airline Industry and Open the Sky Immediately?

Sakakibara, Yasuo, Doshisha Univ., Japan; The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG); 19981201; Volume 3; 14p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

A brief history of deregulation in Japan: 1. Dividing the market into three airlines (1970). 2. Some relaxation of the "constitution" (1985), and 3. More relaxation in domestic market (1995-97). When Japan was allowed to reopen civil aviation and Japan Airlines (JAL) was reestablished in 1953, no Japanese government official, no member of the government committee on civil aviation, and nobody in the airline business could imagine that the new JAL would become profitable in a few years and that it would grow to be one of the established air carriers of the world. Therefore, the civil aviation policy of the Japanese Ministry of Transport (JMAT) was geared entirely to strengthen JAL's position as Japan's "flag carrier." The JAL's performance improved with 'the Jimmu boom' of 1956 Jimmu was the first legendary emperor of Japan, and the term Jimmu boom means boom without any precedent). JAL made a profit from '55 to '61 and paid dividends to private stockholders in '60 for the first time (The government owned the majority of its stocks). On the other hand, none of the many small regional airlines boom after the reopening of the civil aviation were making money. The JMAT recommended (an administrative guidance) that small ones be merged into larger ones. A series of mergers followed and two airlines emerged: All Nippon Airways (ANA) and Toa-Domestic Airlines (TDA ... later changed to Japan Air System, JAS). Soon after the three major airlines, JAL, ANA and TDA, came to existence, an understanding of a cabinet meeting was issued (1970). This understanding came to be called 'the constitution' of civil aviation because it completed the regulatory system and because it was strictly observed, however informal the regulatory dictations were. What the constitution did was to divide the market into three airlines.

Derived from text

*Airline Operations; Civil Aviation; Japan*

19990099352 College of William and Mary, School of Business Administration, Williamsburg, VA USA

Toward a Market-Oriented Air Transport? Recent Developments in Russian Civil Aviation Performance and Policy

Strong, John S., College of William and Mary, USA; The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG); December 1998; Volume 3; 10p; In English; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

After seven years of declining demand and deteriorating performance, the Russian civil aviation sector began what might be an incipient recovery in 1997. This paper describes the performance and emerging industry, structure, and main policy issues as of early 1998. Due to the lack of consistent data and the difficulty securing public release of the information that is available, this paper should not be viewed as a in traditional academic analysis, but rather more of a clinical study.

Author

*Air Transportation; Policies; Russian Federation*

19990099353 Sydney Univ., Australia

The Asian Economic Crisis and Its Implications for Aviation Policy in Asia Pacific

Hooper, Paul, Sydney Univ., Australia; Chin, Anthony, National Univ. of Singapore, Singapore; Cain, Robert, Tourism Futures International, Australia; The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG); December 1998; Volume 3; 10p; In English; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Up until the second half of 1997, there was widespread confidence that commercial air transport activity would grow more quickly in the Asia Pacific region than it would in other markets. The airlines based in the region embarked upon costly re-equipment and expansion plans while the major carriers in North America and Europe actively expanded their presence by extending their networks and alliances. The rapid growth put pressure on the governments in the region to relax their approach to competition and the result was the emergence of new Asian airlines with ambitious plans, open skies agreements with the United States, and agreements to form regional aviation markets in South East Asia. Within APEC there was a commitment to pursue a more competitive air services regime. Even before the currency crises leading to IMF bail-out packages for Thailand, Indonesia and South Korea, the airlines were losing traffic because of a variety of special conditions such as the smog conditions associated with the forest fires in Indonesia. However, the abrupt decline in wealth, the spate of business failures, fears of job insecurity and austere economic programmes that occurred in late 1997 had catastrophic impacts on traffic levels for some markets. At the same time, the region's airlines were highly exposed to currency movements and their debt obligations escalated sharply along with interest rates. Many other airline costs are incurred in hard currencies and the airlines have moved rapidly to refinance their fleets, reorganize their routes and to take greater advantage of alliances. The adjustment process will continue for some time and it will involve far-reaching changes. This paper examines the impacts of the economic crises on the airlines and the responses being pursued by management. Given the trend towards more liberal competition policies, an important question is whether the current circumstances are likely to lead to a return to more protectionist attitudes. The temptation to shield carriers from competition will

have to be balanced against the need to open up markets, to forge alliances and to attract investment. We argue there are strong forces likely to support further liberalisation.

Author

*Airline Operations; Asia; Competition; Economics; Market Research; Policies*

19990099354 General Electric Capital Aviation Services, Stamford, CT USA

Industry Outlook Approaching the Next Millennium

Holden, K. J., General Electric Capital Aviation Services, USA: *The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG)*: December 1998; Volume 3; 21p. In English: Copyright Waived: Avail: CASI; A03, Hardcopy; A03, Microfiche

By any standards, 1997 was a banner year for the aviation industry. World passenger traffic increased by just under 7% over 1996 with the result that total demand was over one-third greater than just four years earlier in 1993 .... an average rate of increase of 7.5% pa or nearly 50% above the consensus forecast for long-run growth. While total deliveries of 100 seat jets increased from 438 in 1996 to 582 last year, the four year average of 490 pa was some 20% less than the consensus forecast of long-run demand. This almost unprecedented four year favorable trend in supply versus demand has resulted in load factors increasing from 66% in 1993 to 71% last year while the number of surplus aircraft declined from nearly 1,200 (11% of the world fleet) at the end of 1993 to 260 representing just 2% of the world fleet at the end of 1997. The world's airlines recorded record net profits of \$7.5B last year compared with \$4.4B losses in 1993 which itself followed record losses of \$7.9B in 1992. The swing for the US airlines, which account for about one-third of world airline revenues, was even more impressive over this five year period ..... going from a \$3B loss in 1992 to a \$4B profit in 1997. Manufacturers, too, have benefited from near record orders for 1,348 new jets in 1997 (a 14% increase over the 1,186 ordered in 1996) bringing the firm order backlog up to 3,117. In the leasing sector, the growing aircraft shortage showed up in terms of strong demand for most popular types of modern narrow-body and wide-body aircraft with a commensurate strengthening of lease rates.

Author

*Aircraft Industry; Airline Operations; Commercial Aircraft; Forecasting; Industries*

19990099355 Kobe Univ., Graduate School of Business Administration, Japan

An Empirical Analysis of Japan's Domestic Airline Markets, Pt. 1, Airfares Under the Regulatory Regime: What will be expected After the Revision of the Current Charging System?

Murakami, Hideki, Kobe Univ., Japan: *The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG)*: December 1998; Volume 3; 31p. In English: Copyright Waived: Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper statistically investigates the charging system of Japanese domestic airfares and predicts the effect of the revision of the current system on the consumer's surplus. Using 222 observations of cross-sectional data from 1995, Part 1 of this paper empirically demonstrates that (1) the airfares in the long haul routes were set relatively high regardless of the number of passengers, (2) in the outstandingly dense routes, the airfares were set higher than the predicted full cost levels, and (3) in the thin and shorter haul routes, airfares were a little lower. Considering the price elasticity of these three types of routes, this paper concludes the reduction of airfares.

Author

*Airline Operations; Costs; Market Research; Statistical Analysis*

19990099356 University of the West Indies, Dept. of Economics, Saint Augustine, Trinidad and Tobago

A Tale of Two Airlines: The Post Privatisation Performance of Two Caribbean Airlines

Melville, Juliet A., University of the West Indies, Trinidad and Tobago: *The Symposium Proceedings of the 1998 Air Transport Research Group (ATRG)*: December 1998; Volume 3; 26p. In English: Copyright Waived: Avail: CASI; A03, Hardcopy; A03, Microfiche

Under severe fiscal pressures and in the wake of continuing poor performance of their airlines, the governments of Jamaica and Trinidad and Tobago were forced to privatise their flag carrier. Privatisation was expected to lead to much improved performance in an increasingly competitive environment. Three years after privatisation and despite the governments taking over all of the airlines' debt, the two privatised airlines have once more accumulated huge losses, with one airline almost on the verge of bankruptcy. This paper takes a comparative look at the post-privatisation performance of both airlines. The paper examines the strategies adopted by these privatised airlines in the face of intense competition from their much larger rivals. Finally the paper considers whether small, unsupported airlines can survive in the new competitive environment.

Author

*Airline Operations; Caribbean Region; Commercial Aircraft; Competition*

19990099361 Nebraska Univ., Aviation Inst., Omaha, NE USA

The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society, Volume 4

Bowen, Brent D., Editor, Nebraska Univ., USA; Oum, Tae Hoon, Editor, British Columbia Univ., Canada; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; 304p; In English; 8th; Transportation Research, 12-17 Jul. 1998, Antwerp, Belgium; Sponsored by World Conference on Transportation Research Society

Contract(s)/Grant(s): NAGw-4414

Report No.(s): UNOAI-98-9; Copyright Waived; Avail: CASI; A14, Hardcopy; A03, Microfiche

The Air Transport Research Group of the WCTR Society was formally launched as a special interest group at the 7th Triennial WCTR in Sydney, Australia in 1995. Since then, our membership base has expanded rapidly, and now includes over 400 active transportation researchers, policy-makers, industry executives, major corporations and research institutes from 28 countries. It became a tradition that the ATRG would hold an international conference at least once a year. In 1998, the ATRG organized a consecutive stream of 14 aviation sessions at the 8th Triennial WCTR Conference (July 12-17: Antwerp). Again, on 19-21 July, 1998, the ATRG Symposium was organized and executed every successfully by Dr. Aisling Reynolds-Feighan of the University College of Dublin. The Aviation Institute at the University of Nebraska at Omaha has published the Proceedings of the 1998 ATRG Dublin Symposium (being co-edited by Dr. Aisling Reynolds-Feighan and Professor Brent Bowen), and the Proceedings of the 1998 WCTR- ATRG Conference (being co-edited by Professors Tae H. Oum and Brent Bowen).

Author

*Air Transportation; Conferences; Operating Systems (Computers)*

19990099363 British Columbia Univ., Faculty of Commerce and Business Administration, Vancouver, British Columbia Canada The Link Between Total Factor Productivity, Prices and Financial Performance: Applications to Air and Rail Transportation

Waters, W. G., II, British Columbia Univ., Canada; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 16p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Total factor productivity (TFP) has been a principal means of measuring performance both for monitoring performance improvement over time as well as performance comparisons across firms. Productivity compares output quantities with quantities of inputs (more specifically, the growth in outputs relative to the growth in inputs). However, strong productivity performance is not necessarily an indicator of strong financial performance; and the converse is true as well, for example, firms with market power can achieve profitability despite poor productivity performance. There is reason to expect some correlation between productivity and financial performance, but the relationship is not exact. Stated simply, productivity compares quantities of outputs relative to quantities of inputs. Financial performance depends on the revenues from outputs compared to the expenditures on inputs. A firm can be very efficient in terms of outputs per input, but it could be highly unprofitable if the revenues received are low compared to what it pays for inputs. Conversely, a firm with market power might be inefficient in input use but compensate financially by charging high prices. Nonetheless, it is possible to establish a direct link between productivity changes and financial performance.

Author

*Productivity; Cost Analysis; Financial Management; Air Transportation; Rail Transportation*

19990099364 Institute for Transport Policy Studies, Tokyo, Japan

Liberalization or Controlled Competition? The Development of Scheduled Domestic Air Transport in Germany and Japan, Focusing on the Fare System

Obermauer, Andrea, Institute for Transport Policy Studies, Japan; Kamiyama, Hiroyuki, Institute for Transport Policy Studies, Japan; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 22p; In English

Report No.(s): Paper-886-Rev; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

For decades domestic air transport markets in Germany and Japan developed in a strictly regulated environment. However, due to political and economical necessities a deregulation process started that led to changes in the market structure especially of scheduled passenger transport. In 1986, the Japanese government changed its air transport policy towards a deregulation policy; in Europe liberalization of air transport was part of the measures to build a common market with equal opportunities for all airlines. In consideration of the results of the rapid deregulation process in the US which caused numerous bankrupts, in Japan and EU it was decided to deregulate the market more gradually. But, whereas in Japan the introduction of new airlines was restricted under law, in Germany, along with the liberalization policy on EU level since the late 1980s, new airlines could enter the scheduled air

transport market starting vivid competition with Lufthansa on some major domestic city-pair relations. In Japan, under the controlled competition system eight airlines compete in the domestic market. Where competition can be offered, price reductions can take place. Therefore, the analysis focuses on the different approach in deregulating the domestic market in both countries. Regarding the effects of deregulation in the Japanese domestic market, recent developments and changes in market structure and passenger fares for both countries will be investigated, thus answering the question whether controlled competition and the still ongoing process of deregulation can lead to fare competition between airlines as it is the case in Germany.

Author

Airline Operations; Civil Aviation; Competition; Market Research; Policies

19990099365 Ecole Nationale de l'Aviation Civile, Management du Transport Aerien, Toulouse, France

France, Progress of the Interior Laboratory of Aerial Transport *La France, Laboratoire du Marche Interieur du Transport Aerien*

Bonnet, Dominique, Ecole Nationale de l'Aviation Civile, France; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 18p; In French; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

After a long period of neglect and waiting which lasted until the bilateral relationship between member states, in the year 1986, there is incontestable progress in the evolution of aerial transport in the European Union. With the signature in February 1986 of the Unique European Act, the beginning of interior progress has been fixed at 31 December 1992. Some weeks much later in April 1986, the Court of European Justice rendered its judgment called "New Frontiers" which stipulated the general rules of relations of Rome, but also their concern with concurrent as applied to aerial transport. Thus was completed the final joining of the political agreement and the judicial conditions which allowed preparation of common aerial transport authority, outlined by the commission in its memorandum of March 1984. The principal support of this policy, the realization of an Interior Department of Aerial Transport was achieved in April 1997 with the establishment of a period of transition and adaptation of about twenty years. The preparations of this work concerned France in two large periods: six years of preparation during of which fixed routes which had been poorly marked were established, (2) the succession of an acceleration phase which imposed, occasionally by radical methods, a complete change in the organization of French Aerial Transport, (3) the multiple consequences imposed on industry, (4) the state, and (5) after the laboratory has been established by this process, the French Aerial Transport should progressively insert gradual growth in true transEuropean research.

Author

Air Transportation; Policies; Progress

19990099366 Technical Univ. of Istanbul, Faculty of Management, Turkey

Air Travel Demand Projections Through 2010: The Case Study of Istanbul Ataturk Airport

Ulengin, Fusun, Technical Univ. of Istanbul, Turkey; Topcu, Ilker, Technical Univ. of Istanbul, Turkey; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 20p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This study evaluates the current traffic capacity of Istanbul Ataturk Airport in order to investigate the possibility of an increase in efficiency and to specify the need for a second airport in Istanbul. The research is based on traffic demand projections (passenger, aircraft, and cargo) for the Ataturk Airport until 2010. Initially, regression models are separately developed for international and domestic passenger traffic, cargo traffic, and aircraft traffic. Subsequently, in order to make reliable projections until 2010, four different scenarios are developed. Scenario 1 is based on trend analysis while the others assume that variables will show fluctuations similar to previous years' but with different rates. Scenario 2 represents the status quo while Scenario 3 and 4 represents the optimistic and pessimistic cases respectively. All the scenarios reveal that the Ataturk Airport urgently needs supplementary terminal buildings and runways, and that a second airport in Istanbul is indispensable.

Author

Air Traffic; Trend Analysis; Evaluation; Air Transportation; Cargo; Passengers

19990099367 Technische Hochschule, Dept. of Flight Guidance and Control/Air Transportation, Berlin, Germany

A Hands-On Analysis of the Future Framework of the European Airline Industry Using a Software-Assisted Scenario-Methodology

Dussoye, S. Sunjay, Technische Hochschule, Germany; Becker, Axel, Daimler-Benz Aerospace A.G., Germany; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 14p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Presently, the European airline industry features some ambivalent characteristics. On the one hand side its passenger numbers as well as its freight tonnage show strong signs of growth, on the other hand side the industry is confronted with a difficult situation, i.e. burdened with infrastructural shortcomings and uncertainties, e.g. with respect to what will happen after the 3-nd liberalisation package has come into effect. Moreover, some airlines already have or are in the midst of undergoing comprehensive restructuring and privatisation, whilst others remain in their respective state's hands yet and/ or are heavily subsidized. This plus the ongoing economic work sharing worldwide, high growth rates in tourism and their influence on aviation necessitate a deeper understanding of and insight into the dependencies of the air transport system. Whereas the airline analyst can assume that most European airlines have already made and are implementing the planning and strategic decisions covering the near future, the more distant future implies more scope of action and thus more uncertainty of what business ideas should be realised and what strategies applied and when. Also, the airline strategist is only partly aware of what prospective activities are pursued by the airline's competitors. Furthermore, technological „quantum leaps“ do not follow deterministic patterns and thus are very difficult to predict. Strategic decisions with regard to greater investments or the implementation of far-reaching strategies focused on various business units (i.e. their market behaviour) require an extensive outlook into the further future. This is imperative for an early identification of relevant developments (early warning) and the realization of their consequences on the industry as a whole, so as to maintain an airline's competitive advantage over its competitors. For this scenarios suggest themselves. Applied to the underlying topic, they serve as a first step to assess the potential of yet-to-be finalized developments within the European airline industry. The aim of the scenario process conducted here is to provide decision-makers in the airline industry, air transport analysts and personnel of state authorities and of other institutions involved with possible, conceivable and consistent future perspectives regarding the European air transport industry. This knowledge will enable all the interested parties to subject their objectives and actions to an examination of costs and benefits, help to avoid or make use of specific risks and chances and to maintain or better their place in the top league. The application of the scenario-methodology to the problem field mentioned above and illustrated in this paper was realised by collaborating with other experts (both scientists and practitioners) from all over the aviation field, following the process in figure 1. The aim was to reach as good an understanding of the European airline industry now and in the future as was possible in the given time frame.

Derived from text

*Technology Transfer; Air Transportation; Airline Operations; Cargo; Early Warning Systems; Government/Industry Relations*

19990099370 Centre for European Economic Research, Mannheim, Germany

External Costs of Road, Rail and Air Transport: A Bottom-Up Approach

Weinreich, Sigurd, Centre for European Economic Research, Germany; Renning, Klaus, Centre for European Economic Research, Germany; Gessner, Christian, Centre for European Economic Research, Germany; Schlomann, Barbara, Fraunhofer-Inst. fuer Systemtechnik und Innovationsforschung, Germany; Engel, Thomas, Fraunhofer-Inst. fuer Systemtechnik und Innovationsforschung, Germany; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 20p; In English

Report No.(s): Paper-938-Rev; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper describes the most important results of the external quality valuation in the QUITs project funded by the European Commission (DG VII) under the Transport RTD Programme of the 4th Framework Programme. The objective of QUITs was to develop a methodology for valuing internal and external quality dimensions of transport systems. A uniform methodology is applied for calculating external costs of transport for different types of impacts and transport modes. The evaluation of the external costs of road, rail and air traffic for both passenger and goods transport is based on a bottom-up approach, which means that the starting point for the analysis is the micro-level. This is standard in cost-benefit analysis. We adopted the impact pathway approach developed in the ExternE project. Due to limited space, this paper will focus on the comparison of external costs between modal alternatives for the route Frankfurt - Milan. This Origin- Destination relation is transnational, covers all major kinds of transport-related externalities and offers a real modal choice. The bottom-up approach can be applied both, to support a netwide analysis and for local and route specific cost-benefit analysis. Monetary valuation is essential to get an orientation towards fair and efficient pricing.

Author

*Air Traffic; Cost Effectiveness; Procedures; Computation*

19990099374 Dalhousie Univ., School of Business Administration, Halifax, Nova Scotia Canada

Performance Evaluation of Carriers by North American Companies

Brooks, Mary R., Dalhousie Univ., Canada; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 20p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

According to the trade press, performance evaluation in North America is well underway. This paper reports the findings of a research study to examine the assessment of carrier performance by users and suppliers of North American transportation services. As a descriptive study, it examines the approaches of cargo suppliers (manufacturers) to the evaluation of their transport suppliers' performance-including incidence of monitoring, methods, responsibility for and use of findings-in order to understand the business practices taking place. These findings are then contrasted with similar elements from the points of view of carriers and logistics service firms. The paper does not explore the issue of performance assessment from a macro-economic focus but rather from one of firm-specific program implementation. It concludes that the perception advanced by the trade press is not the reality reported by companies in the marketplace.

**Author**

*Evaluation; Research; Performance Tests; Transportation; North America*

19990099396 Nebraska Univ., Aviation Inst., Omaha, NE USA

The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society, Volume 2; Oum, Tae Hoon, Editor, British Columbia Univ., Canada; Bowen, Brent D., Editor, Nebraska Univ., USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; 320p; In English; 8th; Transportation Research, 12-17 Jul. 1998, Antwerp, Belgium; Sponsored by World Conference on Transportation Research Society; See also 19990099397 through 19990099414

Contract(s)/Grant(s): NAGw-4414

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Contents include the following: Airport choice in a multiple airport region: an empirical analysis for the San Francisco bay area. Liberalization of the westeuropian aviation: choice of a new hub airport for an airline. Austin Bergstrom airport traffic control tower establishment of a major activity level tower. A study to optimize the environmental capacity of Amsterdam airport schiphol. Airport performance in stakeholder involvement and communication strategies: a comparison of major Australian and North American air carrier and general aviation airports. Airport planning and location. Location of international airport and regional development. A simulation technique for analysis of Brasilian airport passanger terminal building. Multimodal airport access in Japan. Planning surface access provision at major airports. Airline economics and the inclusion of environmental costs on airport hub pricing: a theoretical analysis. Airport financing and user charge systems in the USA. Optimal demand for operating lease of aircraft. Aircraft leasing industry and social welfare. The development of performance indicators for airports: a management perspective. Study about operational effect of the "security check-in" implantation in Brasilian international airports. Austin Bergstrom west loop cable system. and Optimal resource allocation model for airport passanger terminals.

CASI

*Conferences; Resource Allocation; Economics; Costs; Airport Towers; Airport Planning; Aircraft Industry; Airline Operations; Air Traffic Control; Air Transportation*

19990099397 Vrije Univ., Dept. of Regional Economics, Amsterdam, Netherlands

Airport Choice in a Multiple Airport Region: An Empirical Analysis for the San Francisco Bay Area

Pels, Eric, Vrije Univ., Netherlands; Nijkamp, Peter, Vrije Univ., Netherlands; Rietveld, Piet, Vrije Univ., Netherlands; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 22p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this paper a nested logit model is used to describe passenger preferences concerning airports and airlines. A statistical model for the passengers' sequential choice of airport and airline is calibrated. It appears that the choice sequence first airport, then airline is statistically preferable to the reversed choice sequence. Frequency, the average number of seats offered by an airline and access time to the airport are all significant. Separate models are estimated for business and leisure travelers, but there appear to be only small differences.

**Author**

*San Francisco Bay (CA); Airports; Mathematical Models; Numerical Analysis; Commercial Aircraft*

19990099398 Alfa SP IFA, Ljubljana, Slovenia

Liberalisation of the West European Aviation: Choice of a New Hub Airport for an Airline

Milan, Janic, Alfa SP IFA, Slovenia; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 21p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The European air transport system consists of the airports, air traffic control and airlines. The physical characteristics and traffic volumes of the European air transport system have been impressive. According to data provided by A.E.A. (Association

of European Airlines), over 210 airports have operated in the Western Europe. In the EU (European Union) countries over 100 airports have served the annual traffic overcoming more than 250000 air passengers and 10000 tonnes of air cargo (104 cities have been served by 110 airports). The European air traffic has been controlled by 45 Air Traffic Control centres which have been sub-divided into 191 low-altitude and 212 high-altitude sectors (CEC, 1994). More than 200 airlines have operated at the Western European airports (approximately 145 of them have managed their flights within the EU Member States). They have carried out about 50% of all services as scheduled services. The most famous European airlines have been 22 'flag-carriers'. They have scheduled their flights on the main inter-European and intercontinental routes. The largest airlines have been Lufthansa, British Airways and Air France. Each of them has transported more than 28 million passengers per year (ATAG, 1996; Janic, 1996). The European aviation market represents an important part of the world's aviation market. The following figures support this assertion (ATAG, 1996). In 1993 the total air transport demand was nearly 390 million of passengers. Domestic scheduled and charter traffic represented about 30% of this total. International scheduled traffic shared a little bit more than 50% of the total. International charter participated in this total with about 20%. Whole region shared around 54% of the total world-wide international scheduled traffic. More than a half of these passengers traveled over Europe. For years, the dominant inter-European traffic flows have run between UK (UK) and France (around 6.2 million), UK and Germany (5.13 million), and UK and Ireland (4.3 million). (ATAG, 1996). The relationships between the airlines operating in the European air route network have been regulated for years by more than 200 bilateral agreements (Button and Swann, 1991). In 1987 the process of gradual liberalisation (deregulation) of the EU (European Union) aviation markets started. It has lasted for the past decade (1987/1993/1997). The process has been performed by implementation of three 'Aviation Liberalisation Packages' which provided institutional (legislative) conditions for free operations of the EU airlines over the area of Member States. Although they have completely started to be in effect from January 1993 the last barrier has been removed in April 1997. After that time, as in US the airlines have become freed to fly anywhere they want (between any two points) within the EU, set-up the airfares and enter or leave from the particular markets (routes). The national flag airlines have been consolidating their domestic hub-and-spokes networks for years. After full liberalisation (deregulation) of the EU market, some of them will intend to strengthen their presence in the 'core' area of Europe (IFAPA, 1988; Janic, 1996). Besides the merging and alliances this will be carried out by establishing of a new hub airport in the core area'. The objective of this paper has been to develop the methodology which will be able to support easier, more transparent and consistent choice of a new hub airport by an airline. Besides this introductory section, the paper consists of five sections. Section 2 describes the 'Liberalisation Packages' concerning the EU aviation market. As well, it contains description of the main developments of this market that have happened for the past decade. Section 3 deals with the problem of 'crossing the national borders' by the airlines during 'transition' period. Section 4 covers the proposed methodology for evaluation of the 'preferable' location of new 'hub' airport. Section 5 contains the numerical example. The last Sections (6) represents the conclusions.

Author

*Air Traffic Control; Air Transportation; Airline Operations; Airports; Commercial Aircraft; Market Research*

19990099407 Geneva Univ., Dept. of Economics, Geneva, Switzerland

Airline Economics and the Inclusion of Environmental Costs on Airport Hub Pricing: A Theoretical Analysis

Nero, Giovanni, Geneva Univ., Switzerland; Black, John A., New South Wales Univ., Australia; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 28p; In English; See also 19990099396

Contract(s)/Grant(s): SNSF-8212-50417; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Previous studies into hub airports have tended to concentrate on the economic dimensions, such as market power, airline fares and barriers to entry. Airline hubbing has considerably altered airport economics: it increases the number of flights into and out of a major airport and it increases externalities such as airside and landside congestion, aircraft noise and emissions. The principal contribution of our paper is to focus on the environmental externalities associated with extensive hubbing. In the first part of the paper we present a conceptual spatial model which addresses the environmental impacts related to extensive hubbing. In the second part of the paper, we formally address the conceptual problem by proposing a model of airline economics. Schmalensee's (1977) model is adapted to allow for a monopolist airline to determine the optimal network and, to set prices and the number of flights. Finally, the paper explores the effect of charging the airline for these externalities through an 'environmental' tax when it operates a hub-and-spoke network. We examine two scenarios, a passenger-related tax and an aircraft-related tax and show the extent to which prices and the number of flights are affected by the tax.

Author

*Airline Operations; Economics; Environmental Control; Numerical Analysis; Airports*

19990099409 British Columbia Univ., Faculty of Commerce and Business Administration, Vancouver, British Columbia Canada  
Optimal Demand for Operating Lease of Aircraft

Oum, Tae Hoon, British Columbia Univ., Canada; Zhang, Anming, City Univ. of Hong Kong, Hong Kong; Zhang, Yimin, City Univ. of Hong Kong, Hong Kong; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 26p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Operating lease of the aircraft gives the airlines flexibility in capacity management. However, airlines pay a risk premium to the leasing companies for bearing part of the risks. Therefore, the airlines face a trade-off between flexibility of capacity and higher costs. This paper develops a model for the airlines to determine their optimal mix of leased and owned capacity, taking into consideration that the demand for air transportation is uncertain and cyclical. Empirical results based on the model suggested that the optimal demand by 23 major airlines in the world would range between 40 to 60 percent of their total fleet, for the reasonable range of premiums of operating lease. For the leasing companies, this indicates huge potential of the market given strong forecast for the growth of air transportation in the next decade.

Author

*Air Transportation; Airline Operations; Commercial Aircraft; Costs; Tradeoffs; Leasing*

19990099410 British Columbia Univ., Faculty of Commerce and Business Administration, Vancouver, British Columbia Canada  
Aircraft-Leasing Industry and Social Welfare

Oum, Tae Hoon, British Columbia Univ., Canada; Zhang, Anming, City Univ. of Hong Kong, Hong Kong; Zhang, Yimin, City Univ. of Hong Kong, Hong Kong; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 22p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Aircraft leasing has become an increasingly important tool for airline financing. This paper considers the effect of the aircraft-leasing market on the efficiency of the airline industry. Since the aircraft-leasing companies represent an extra layer between aircraft users and aircraft manufacturers, the leasing market adds to the costs of aircraft financing. This paper shows that the aircraft-leasing market serves a valuable social function by improving allocative efficiency of the airlines. The leasing market allows the airlines opportunity to adjust capacity so that the shadow value of capacity can be aligned with the cost of capacity. This is difficult to achieve without the leasing market due to the substantial delivery lag with the aircraft manufacturers. As a result, use of aircraft leasing may increase the expected profits of the airlines even though the airlines are paying higher capacity costs. The paper also points out that the existence of the aircraft-leasing market may change the aggregate demand for aircraft by the airlines. Specifically, if the shadow value of capacity is nonlinear in capacity, then the aggregate of the optimal capacity of all the airlines in the absence of leasing market differs from the aggregate of the optimal capacity of all the leasing companies supplying to the airlines. This implies that simply aggregating airlines' traffic forecast could lead to erroneous order decision or production plan by the leasing companies or the aircraft manufacturers.

Author

*Leasing; Commercial Aircraft; Airline Operations*

19990099412 Instituto Tecnologico de Aeronautica, Sao Paulo, Brazil

Study About Operational Effects of the "Security Check-In" Implantation in Brazilian International Airports

de Almeida, Paulo Marcos Santo, Instituto Tecnologico de Aeronautica, Brazil; Alves, Claudio Jorge Pinto, Instituto Tecnologico de Aeronautica, Brazil; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 10p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

With the growing of the air traffic, the passengers' terminals have been presenting an increase of congestion situations in the departure as in arriving processes. Such congestion can cause delays and queues, affecting the passengers perception on quality of service offered. On this aspect the airline should have a concern about the departure process that, how it's administered by its own, contribute strongly to the image of the company to its customers. Specifically for North American airlines and for some other ones with flights to the United States of America, there is the "security check-in" procedure. This procedure came from the need of these companies to protect their aircraft and their passenger from the international terrorism growing. This became a demand of FAA (Federal Aviation Administration - USA) for the aircraft destined to the United States of America. The inclusion of the "security check-in" can influence the operational performance of departure affecting the user perception in relation to the airline offered. In this group of airlines American Airlines is included. The verification of the occurrence of deficiencies in the departure components can be done through the comparison among the performance patterns used by the airline and the measured ones. This

is done in this work monitoring the process of "security check-in" and "check-in" through the mensuration of important parameters, as time of processing and number of people in queue.

Author

*Research; Airline Operations; Airports; Civil Aviation; Passengers; Security*

19990100640 FDC/NYMA, Inc., Aerospace Sector, Hampton, VA USA

The Typical General Aviation Aircraft *Final Report*

Tumblin, Andrew, FDC/NYMA, Inc., USA; September 1999; 32p; In English

Contract(s)/Grant(s): NAS1-96013; RTOP 538-11-22-01

Report No.(s): NASA/CR-1999-209550; NAS 1.26:209550; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The reliability of General Aviation aircraft is unknown. In order to "assist the development of future GA reliability and safety requirements", a reliability study needs to be performed. Before any studies on General Aviation aircraft reliability begins, a definition of a typical aircraft that encompasses most of the general aviation characteristics needs to be defined. In this report, not only is the typical general aviation aircraft defined for the purpose of the follow-on reliability study, but it is also separated, or "sifted" into several different categories where individual analysis can be performed on the reasonably independent systems. In this study, the typical General Aviation aircraft is a four-place, single engine piston, all aluminum fixed-wing certified aircraft with a fixed tricycle landing gear and a cable operated flight control system. The system breakdown of a GA aircraft "sifts" the aircraft systems and components into five categories: Powerplant, Airframe, Aircraft Control Systems, Cockpit Instrumentation Systems, and the Electrical Systems. This breakdown was performed along the lines of a failure of the system. Any component that caused a system to fail was considered a part of that system.

Author

*General Aviation Aircraft; Aircraft Reliability; Component Reliability; Aircraft Safety; System Failures*

19990101882 Army Safety Center, Fort Rucker, AL USA

FLIGHTFAX: Army Aviation Risk-Management Information. June 1999, Volume 27, Number 6

Jun. 1999; 13p; In English

Report No.(s): AD-A364895; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

This document contains information concerning Army aviation safety, tree strike accident investigations, and aviation accident prevention.

DTIC

*Aircraft Accidents; Accident Prevention; Aircraft Safety*

19990103936 National Transportation Safety Board, Washington, DC USA

National Transportation Safety Board Transportation Initial Decisions and Orders and Board Opinions and Orders Adopted and Issued during the Month of June 1999

Jun. 1999; 206p; In English

Report No.(s): PB99-916706; NTSB/IDBOO-99/06; No Copyright; Avail: CASI; A03, Microfiche; A10, Hardcopy

This publication contains all Judges Initial Decisions and Board Opinions and Orders in Safety and Seaman Enforcement Cases for June 1999.

NTIS

*Safety Management; Air Transportation*

## 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

*Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.*

19990087809 Beijing Univ. of Aeronautics and Astronautics, Beijing, China

Research on the Characteristic of Optimal Flight Route in the Terminal Area

Xue, Li-Lin, Beijing Univ. of Aeronautics and Astronautics, China; Wang, Wei-Hong, Beijing Univ. of Aeronautics and Astronautics, China; Gao, Jin-Yuan, Beijing Univ. of Aeronautics and Astronautics, China; Journal of Beijing University of Aeronautics and Astronautics; December 1998; ISSN 1001-5965; Volume 24, No. 6, pp. 692-694; In Chinese; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

A method named multi-times optimization is presented to solve the multi-specification optimization problem, which is difficult to solve using the variational optimal theory. In the method several demands are reduced to some sub-tasks. In every subtask a demand that cannot be transformed into bound condition is taken as performance specification for optimization, and the other demands are taken as bound conditions. by means of the method, the arrival time, number of turn, turn angle of the aircraft in the terminal area are selected as performance specification separately, and the general character of optimal flight route in the terminal area is given.

**Author**

*Flight Optimization; Flight Paths; Air Traffic Control; Flight Control*

19990092219 Defence Science and Technology Organisation, Aeronautical and Maritime Research Lab., Melbourne, Australia  
Trial of Global Positioning System Based Field Wreckage Plotting and Analysis Equipment Using Data from a USMC F/A-18 Aircraft Accident

Baxter, Simon A., Defence Science and Technology Organisation, Australia; Molent, Loris, Defence Science and Technology Organisation, Australia; June 1999, 62p; In English; Original contains color illustrations

Report No.(s): DSTO-TR-0828; DODA-AR-010-993; Copyright: Avail: Issuing Activity (DSTO Aeronautical and Maritime Research Lab., PO Box 4331, Melbourne, Victoria 3001, Australia), Hardcopy

On August 20, 1998 a USA Marine Corps F/A-18 aircraft crashed at Delamere bombing range in the Northern Territory. AMRL was invited to aid in the investigation by trailing the AMRL wreckage mapping and analysis equipment at the site. The equipment was used to plot and record all wreckage of interest. Maps of the wreckage were produced on site and handed over to the accident investigation team. These rapidly produced maps, along with the experience brought with the AMRL investigators with on site wreckage examination, greatly aided the accident investigation team to expedite recovery of the site and clarify many aspects of the accident. to this end, the trial of the equipment was very successful. Following this trial, the data was used to explore the capabilities of other visualisation software, and its relevance to accident investigation. The results of this are presented during the discussion of the accident.

**Author**

*Global Positioning System; Mapping; Accident Investigation*

19990092477 Federal Aviation Administration, Atlantic City, NJ USA

Air Traffic Control Specialist Performance Measurement Database

Hadley, Gerald A.; Guttman, Jerry A.; Stringer, Paul G.; Jun. 1999; 57p; In English

Report No.(s): AD-A366352; DOT/FAA/CT-TN99/17; No Copyright; Avail: CASI; A01, Microfiche; A04, Hardcopy

The Air Traffic Control Specialist (ATCS) Performance Measurement Database is a compilation of performance measures and measurement techniques that researchers have used. It may be applicable to other human factor research related to air traffic control (ATC). This database is a tool that can be used in conjunction with ATC simulators, generic sector configurations and scenarios, and other procedures used in assessing ATC system safety and effectiveness. Having a set of measures with standardized parameters will increase the reliability of results across experiments and enable comparisons of results across evaluations. At this time, it is unlikely that the database includes all of the measures that are applicable to ATC assessments. However, the database is designed to be an adaptive research tool, and the authors invite your nominations of other measures for the database.

**DTIC**

*Air Traffic Control; Data Bases; Systems Engineering*

19990092712 Draper (Charles Stark) Lab., Inc., Cambridge, MA USA

Autolanding Trajectory Design for the X-34

Barton, Gregg H., Draper (Charles Stark) Lab., Inc., USA; Tragesser, Steven G., Draper (Charles Stark) Lab., Inc., USA; 1999; 10p; In English; Atmospheric Flight Mechanics, 9-11 Aug. 1999, Portland, OR, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): NAS8-40887

Report No.(s): AIAA Paper 99-4161; Copyright: Avail: Issuing Activity, Hardcopy

An Autolanding 1-load Program (ALIP) is developed to design unpowered autolanding trajectories for the X-34 Mach 8 vehicle. The trajectory is comprised of geometric flight segments that are based on the shuttle approach and landing design (steep glideslope, circular flare, exponential flare to shallow glideslope). Enforcing physical constraints such as loads, vertical descent rate, continuity and smoothness reduces the design problem to a two point boundary value problem with conditions on the initial and final dynamic pressure. Finding a solution required the development of trajectory simulation techniques that constrained the flight profile to a prescribed geometry. The design methodology can be extended beyond the autolanding flight regime by

repeating the series of geometric segments and solving multiple two-point boundary values problems (one for each series). The techniques described in this paper facilitate rapid design of reference trajectories.

**Author**

*Flight Paths; X-34 Reusable Launch Vehicle; Landing Simulation; Descent Trajectories; Automatic Landing Control; Algorithms*

**19990092822 DaimlerChrysler Aerospace A.G., Military Aircraft Div., Munich, Germany**

Tactical Missions of Transport Aircraft: A Proven Low Level Guidance Concept to Reduce Crew Workload

Lerche, H. D., DaimlerChrysler Aerospace A.G., Germany; Mehler, F., DaimlerChrysler Aerospace A.G., Germany; Sensor Data Fusion and Integration of the Human Element: February 1999, pp. 20-1 - 20-8; In English; See also 19990092805; Original contains color illustrations; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

A concept for a new flight guidance system focuses on the problem of low level flight and reduction of crew workload for a military transport aircraft is presented. A digital terrain database is used to eliminate the need for an active forward looking radar, thus permitting silent terrain following and terrain avoidance. Coupled to the database are a highly reliable, precision navigation, 4D flight guidance and display functions. The demonstration of key technologies associated with this system has been carried out in several R&D programs to prove the high maturity of available technologies and to reduce the development risks. The target aircraft for these studies is the future European tactical transport aircraft, known as Future Large Aircraft or Future Transport aircraft. The present low level flight technical solution has been prototyped and tested by the German Air Force in the Airbus Experimental Cockpit Simulator and two flying testbeds (C160 Transall, and ATTAS). The experimental verification process is still currently in progress.

**Author**

*Data Bases; Display Devices; Navigation; Terrain; Terrain Following; Obstacle Avoidance; Transport Aircraft; Aircraft Instruments; Flight Instruments*

**19990094488 University of Southern Illinois, Carbondale, IL USA**

The Navstar Global Positioning System: A Global Utility?

Miller, Irene A., University of Southern Illinois, USA; Collegiate Aviation Review: Sep. 1998, pp. 24-39; In English; See also 19990094485; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Satellite-based navigation systems are one of the fastest growing sectors of the space industry. The Navstar Global Positioning System (GPS) is a fully operational US military satellite-based navigation system. New applications, both civilian and military, are continually being developed for GPS and increasing numbers of users worldwide are becoming dependent upon this technology. The airline industry is but one segment of the rapidly growing GPS user base. New technologies evolving from GPS are quickly advancing the usefulness of GPS, which presents the need for international and national policy. The users of GPS technology, such as the airline industry, are having considerable influence over the development of GPS policy as a result of civil users exercising increasing control over the system. The use of GPS for navigation by the airline industry presents the unique challenge of integrating air and space law. This paper will discuss pertinent legal and policy issues that will affect the development of GPS policy such as liability, sovereignty, and GPS availability. According to some authorities, as GPS becomes an international utility it may present the requirement for an international organization, like the International Civil Aviation Organization (ICAO) or another consortium to establish the policy. The International Telecommunication Satellite Organization (INTELSAT) may serve as a model for a navigational consortium. This paper examines the various national and international organizations that may serve as models to develop GPS policy in the future.

**Author**

*Global Positioning System; Navstar Satellites; Navigation; Technology Assessment; Telecommunication*

**19990098414 NASA Goddard Space Flight Center, Greenbelt, MD USA**

Pre-Flight Testing of Spaceborne GPS Receivers using a GPS Constellation Simulator

Kizhner, Semion, NASA Goddard Space Flight Center, USA; Davis, Edward, NASA Goddard Space Flight Center, USA; Alonso, R., National Commission of Space Activities, Argentina; I 1999; 11p; In English; ION GPS 1999, 14-17 Sep. 1999, Nashville, TN, USA; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The NASA Goddard Space Flight Center (GSFC) Global Positioning System (GPS) applications test facility has been established within the GSFC Guidance Navigation and Control Center. The GPS test facility is currently housing the Global Simulation Systems Inc. (GSSI) STR2760 GPS satellite 40-channel attitude simulator and a STR4760 12-channel navigation simulator. The facility also contains a few other resources such as an atomic time standard test bed, a rooftop antenna platform and a radome. It provides a new capability for high dynamics GPS simulations of space flight that is unique within the aerospace community. The GPS facility provides a critical element for the development and testing of GPS based technologies i.e. position,

altitude and precise time determination used on-board a spacecraft, suborbital rocket balloon. The GPS simulation system is configured in a transportable rack and is available for GPS component development as well as for component, spacecraft subsystem and system level testing at spacecraft integration and test sites. The GPS facility has been operational since early 1996 and has utilized by space flight projects carrying GPS experiments, such as the OrbView-2 and the Argentine SAC-A spacecrafts. The SAC-A pre-flight test data obtained by using the STR2760 simulator and the comparison with preliminary analysis of the GPS data from SAC-A telemetry are summarized. This paper describes pre-flight tests and simulations used to support a unique spaceborne GPS experiment. The GPS experiment mission objectives and the test program are described, as well as the GPS test facility configuration needed to verify experiment feasibility. Some operational and critical issues inherent in GPS receiver pre-flight tests and simulations using this GPS simulation, and test methodology are described. Simulation and flight data are presented. A complete program of pre-flight testing of spaceborne GPS receivers using a GPS constellation simulator is detailed.

Author

*Flight Tests; Global Positioning System; Satellite Constellations; Navigation Satellites; Receivers*

19990098700 Norwegian Defence Research Establishment, Kjeller, Norway

Integrated Camera-Based Navigation *Integrert Bildebasert Navigasjon*

Hafskjold, Brita Helene, Norwegian Defence Research Establishment, Norway; May 15, 1999; 182p; In Norwegian; Original contains color illustrations

Contract(s)/Grant(s): FFIE Proj. 710.0/132.4

Report No.(s): FFI/RAPPORT-99/02703; No Copyright; Avail: CASI; A09, Hardcopy; A02, Microfiche

In this report an integrated INS and camera-based navigation system is presented. The camera-based navigation system provides position measurement aiding to the INS. This is an alternative to the conventional GPS (Global Positioning System) aided INS. GPS is vulnerable for jamming and other disturbances. Camera-based navigation can not that easily be disturbed, and an INS is impossible to jam. By combining these two navigation principles in an integrated system, we get a system that joins the precise measurement of high frequency motion that the INS delivers, and the low drift rate that the camera-based navigation offers. The system works as follows: A camera (strapdown) captures the terrain. Certain terrain points are chosen (called landmarks), that can be easily recognized in a sequence of pictures. By keeping track of these points and their motion in the picture frame (called picture marks), the camera-based navigation gets vehicle movement information. Every sample time, the INS computes an estimate of the vehicle position and orientation. The integration with the camera-based navigation is done by using these estimates together with the position of the landmarks to calculate predicted positions of the picture marks. The difference between the predicted positions and the measured positions is used by an error-state Kalman filter to estimate the INS errors. This filter has been implemented and tested in a simulator, giving circular position errors typically in the range of 5-30 meters during a 30 min flight. The system is generally improved by increasing the picture frequency, increasing the number of landmarks and reducing the vehicle speed.

Author

*Navigation Instruments; Navigation Aids; Cameras; Jamming; Position Errors*

19990102206 NASA Marshall Space Flight Center, Huntsville, AL USA

1998 Guidance, Navigation, and Control Highlights

Polites, Michael E., NASA Marshall Space Flight Center, USA; December 1998; In English; Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

This article summarizes the highlights of recent events and developments in guidance, navigation, and control in space, aircraft, and weapons. The article is about 1,200 words long. Information for the article was collected from other NASA Centers, DoD, and industry. All information collected was previously cleared by the originating organizations. Information for the article was also gathered from Aviation Week and Space Technology, Space News, and similar sources.

Author

*Guidance (Motion); Spacecraft Control; Navigation; Product Development*

19990102903 NASA Marshall Space Flight Center, Huntsville, AL USA

Recent Events in Guidance, Navigation, and Control Highlights

Polites, Michael E., NASA Marshall Space Flight Center, USA; 1999; In English; 1999 Guidance, Navigation and Control, Aug. 1999, USA; Sponsored by American Inst. of Aeronautics and Astronautics; Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

This article summarizes the highlights of recent events and developments in guidance, navigation, and control in space, aircraft, and weapons. This article is about 3,600 words long. Information for the article was collected from other NASA Centers,

DoD, and industry. All information was previously cleared by the originating organizations. Information for the article was also gathered from Aviation Week and Space Technology, Space News, and similar sources.

Author

*Guidance (Motion); Spacecraft Control; Air Navigation; Space Navigation; Flight Control*

19990103019 NASA Marshall Space Flight Center, Huntsville, AL USA

Recent Events in Guidance, Navigation, and Control

Polites, Michael E., NASA Marshall Space Flight Center, USA; [1998]; In English; Guidance, Navigation, and Control, 10-12 Aug. 1998, Boston, MA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; Copyright: Avail: Issuing Activity: Abstract Only, Hardcopy, Microfiche

This article summarizes the highlights of recent events and developments in guidance, navigation, and control in space, aircraft, and weapons. Information for the article was collected from other NASA Centers, DoD, and industry. All information collected was previously cleared by the originating organizations. Information for the article was also gathered from Aviation Week and Space Technology, Space News, and similar sources.

Author

*Aerospace Engineering; Guidance (Motion); Navigation; Spacecraft Control*

19990103599 NASA Goddard Space Flight Center, Greenbelt, MD USA

Autonomous Navigation Using Celestial Objects

Folta, David, NASA Goddard Space Flight Center, USA; Gramling, Cheryl, NASA Goddard Space Flight Center, USA; Leung, Dominic, Computer Sciences Corp., USA; Belur, Sheela, Computer Sciences Corp., USA; Long, Anne, Computer Sciences Corp., USA; 1999; 3p; In English; 1999 Astrodynamics Specialists, Aug. 1999, Girdwood, USA; Sponsored by American Astronautical Society; No Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

In the twenty-first century, National Aeronautics and Space Administration (NASA) Enterprises envision frequent low-cost missions to explore the solar system, observe the universe, and study our planet. Satellite autonomy is a key technology required to reduce satellite operating costs. The Guidance, Navigation, and Control Center (GNCC) at the Goddard Space Flight Center (GSFC) currently sponsors several initiatives associated with the development of advanced spacecraft systems to provide autonomous navigation and control. Autonomous navigation has the potential both to increase spacecraft navigation system performance and to reduce total mission cost, by eliminating the need for routine ground-based orbit determination and special tracking services, autonomous navigation can streamline spacecraft ground systems. Autonomous navigation products can be included in the science telemetry and forwarded directly to the scientific investigators. In addition, autonomous navigation products are available onboard to enable other autonomous capabilities, such as attitude control, maneuver planning and orbit control, and communications signal acquisition. Autonomous navigation is required to support advanced mission concepts such as satellite formation flying. GNCC has successfully developed high-accuracy autonomous navigation systems for near-Earth spacecraft using NASA's space and ground communications systems and the Global Positioning System (GPS). Recently, GNCC has expanded its autonomous navigation initiative to include satellite orbits that are beyond the regime in which use of GPS is possible. Currently, GNCC is assessing the feasibility of using standard spacecraft attitude sensors and communication components to provide autonomous navigation for missions including: libration point, gravity assist, high-Earth, and interplanetary orbits. The concept being evaluated uses a combination of star, Sun, and Earth sensor measurements along with forward-link Doppler measurements from the command link, carrier to autonomously estimate the spacecraft's orbit and reference oscillator's frequency, to support autonomous attitude determination and control and maneuver planning and control, the orbit determination accuracy should be on the order of kilometers in position and centimeters per second in velocity. A less accurate solution (one hundred kilometers in position) could be used for acquisition purposes for command and science downloads. This paper provides performance results for both libration point orbiting and high Earth orbiting satellites as a function of sensor measurement accuracy, measurement types, measurement frequency, initial state errors, and dynamic modeling errors.

Author

*Automatic Control; Autonomous Navigation; Celestial Bodies; Satellite Orbits; Space Navigation; Algorithms*

19990105719 Air Force Scientific Advisory Board, Washington, DC USA

Global Air Navigation Systems, Volume 2, Detailed Findings. *Final Report, Jan.-Dec. 1997*

McCall, G., Sep. 1998, 169p; In English

Report No.(s): AD-A367419, SAB-TR-97-02-VOL-2; No Copyright; Avail: CASE; A08, Hardcopy; A02, Microfiche

This report presents the detailed findings of the 1997 Air Force Scientific Advisory Board (SAB) study on Global Air Navigation Systems (GANS). Major issues and requirements for GANS are discussed, including capabilities vs. equipment, the

impact of GATM noncompliance, technology needs, proposed acquisition and management strategy with the Air Force in leadership role, ground and future service provider infrastructure including ATC, international aspects, liability, demonstrations, datalinks, GPS/INS technical information, and airspace deconfliction implications for the Department of Defense (DoD). Changes in the global civil airspace architecture will necessitate changes in Air Force equipment and procedures. The GANS Study attempted to identify, define, and categorize the modifications and additions necessary for DoD aircraft and ground systems to operate in the new environment in terms of urgency and utility. Needs and possibilities for navigation systems to be used by the USAF of the 21st century were examined. Departure, en route, and landing procedures and requirements were studied. New GATM requirements will affect space and ground systems as well as aircraft.

DTIC

*Air Navigation; Air Traffic Control; Global Positioning System; Civil Aviation*

## 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

*Includes aircraft simulation technology.*

19990087897 Beijing Univ. of Aeronautics and Astronautics, Beijing, China

Research on Optimal Pointing Maneuvers of Post Stall Aircraft

Zhang, Shu-Guang, Beijing Univ. of Aeronautics and Astronautics, China; Sun, Jin-Biao, Air Force Command Coll., China; Journal of Beijing University of Aeronautics and Astronautics; December 1998; ISSN 1001-5965; Volume 24, No. 6, pp. 650-653; In Chinese; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

A terminal condition is put forward based on nonlinear point-mass aircraft dynamics, under which the given movable target shall be pointed. A numerical procedure on optimization of minimum-time pointing maneuvers is then established, in which the conjugate gradient method is employed to search for the optimal solution, and a punishment function is defined to handle the constraints. Numerical results show that the procedure can help ascertain the "best" maneuvers for different tactics requirements. Also shown is that the capability of rapid deep post-stall entry plays an unusual role in target pointing and shooting in within-visual-range air combat, as well as the capability of swift flight path reorientation which mainly stresses on the maximum lift.

Author

*Flight Characteristics; Flight Paths; Aircraft Maneuvers; Controllability; Flight Control; Maneuverability; Aircraft Control; Air Traffic Control*

19990088110 Air Force Logistics Management Center, Gunter AFS, AL USA

Civil Air Patrol (CAP) Aircraft Requirement Study Final Report

Mercher, Christopher L.; Green, Daniel J.; Apr. 1999; 49p; In English

Report No.(s): AD-A366384; AFLMA-LM199900600; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

The Air Force Audit Agency (AFAA) concluded in its Report of Audit EB0980013 (13 May 98), Air Force Oversight of CY 1996 Civil Air Patrol Corporation Activities, CAP-USAF, Maxwell AFB, AL 36112-6323 (Project 96516051), that CAP-USAF accepted from Civil Air Patrol, Incorporated, (hereafter referred to as CAP) aircraft and motor vehicle reimbursement requests without independently validating the need for the size of the fleets. The USAF reimburses CAP for Air Force assigned missions in accordance with the MEMORANDUM OF UNDERSTANDING between the USA Air Force and Civil Air Patrol (25 January 1991, amended 8 November 1991) and CAP Regulation 173-3 (1 May 1996) and is discussed in more detail on page 2 of this report. As a result, the AFAA estimated appropriated funds were used to reimburse CAP for 200 to 373 unnecessary aircraft (approximate value of \$15M to \$27M) and associated operational costs. In Sep 98, HQ AETC/LG tasked the AFLMA to determine the appropriate CAP aircraft fleet size (requirement) to perform its mission. The objectives of the study were to determine the appropriate CAP aircraft fleet size to support: (1) USAF assigned reimbursable missions (those missions categorized as CAP "A" missions in appendix B); (2) USAF assigned non-reimbursable missions (those missions categorized as CAP "B" missions in appendix B) plus number (1) above; and (3) All other CAP Corporate missions (those missions categorized as CAP "C" or "D" missions in appendix B) plus number (2) above.

DTIC

*Civil Aviation; Patrols*

19990089236 RAND Corp., Santa Monica, CA USA

Innovative Management in the DARPA High Altitude Endurance Unmanned Aerial Vehicle Program. Phase 2 Experience

Dreznar, Jeffrey A.; Sommer, Geoffrey; Leonard, Robert S.; Jan. 1999; 159p; In English

Contract(s)/Grant(s): DASW01-95-C-0059

Report No.(s): AD-A366229; RAND/MR-1054-DARPA; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

Improving acquisition policy, processes, and management requires the accumulation of experience from ongoing or recently completed projects, especially those involving unusual situations or innovative acquisition policies. This research contributes to that understanding through its close work with the DARPA High Altitude Endurance (HAE) Unmanned Aerial Vehicle (UAV) program office, whose acquisition strategy represents a radical departure from normal Department of Defense (DoD) procedures. The objectives of this research are to understand how the innovations affect program outcomes and to identify the lessons of the HAE UAV program that might be applied to a wider variety of projects to improve DoD acquisition strategies.

DTIC

*Pilotless Aircraft; Policies; Management Planning*

19990089242 Army Command and General Staff Coll., School of Advanced Military Studies, Fort Leavenworth, KS USA

Hiding the Helicopters: They Know You Are There, But What Are you Doing and Where Are You Going

Butts, Gregory K.; Dec. 16, 1998; 60p; In English

Report No.(s): AD-A366189; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This monograph discusses surprising the enemy through the use of deception during air assault operations. It focuses at the tactical level of war. Its purpose is to explore whether or not there are tactics, techniques, and procedures that can be used to deceive the enemy as to where the helicopters are going. Brief investigation has revealed that deception is not used often at Combat Training Centers and that the loss of surprise is the single most devastating cause of poor performance of air assault units. This monograph first examines doctrine and theory. It concludes that doctrine is available, but with few practical examples. Theory supports surprise as a goal during all operations, but theorists support varying levels of commitment to the use of deception to attain surprise. The author concludes that in light of today's improved air mobility each theorist considered would support the use of deception during air assault operations. After reviewing the doctrine and theory the monograph reviews several historical examples from World War II and Vietnam. Operation BERTRAM, which occurred in North Africa, D-day, and Corregidor are several of the operations reviewed. Operations reviewed from Vietnam include JUNCTION CITY and CEDAR CREEK. The principle finding is that deception is a valuable part of the art of war during air assault operations. The vulnerabilities of helicopters and their thin skinned cargo makes surprise essential to the reduction of casualties, equipment loss, and risk. History gives us numerous examples of tactics, techniques, and procedures for using deception to gain surprise. This monograph provides an air assault planner with several methods that have proven successful in deceiving the enemy as to where the helicopters are going. Essentially, they allow a planner to hide the helicopters.

DTIC

*Helicopters; Deception; Radar Detection; Electronic Warfare*

19990089860 Department of Defense, Office of the Inspector General, Arlington, VA USA

C-17 Landing Gear Durability and Parts Support

Gimble, Thomas E.; Brannin, Patricia A.; Santoni, Charles; Martin, Delpha W.; Garcia, Ramon; Jun. 24, 1999; 36p; In English

Report No.(s): AD-A366373; RN-99-193; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

This report addresses C-17 landing-gear durability and tire and brake support. This report is the second in a series on the life-cycle management program for military aircraft landing-gear parts. The first report addressed the serialization of fracture-critical and landing-gear parts for the C-17. The overall audit objective was to determine whether the Military Departments were making provisions for landing-gear life-cycle management programs on aircraft acquisition and modification programs. The objective of this segment of the audit was to determine whether the C-17 System Program Office was providing life-cycle management of landing-gear durability and support. We also reviewed the management controls applicable to that objective. Design of the C-17 landing-gear posts and trunnions had not been sufficiently stabilized to enable the C-17 System Program Office to fully project life cycle management cost of landing-gear support. If the contractor is unable to extend the life of those parts, through redesign, past the 1.5 lifetimes of durability testing warranted in the contract, and those parts are declared life-limited, the Government costs for C-17 landing-gear support over the life of the C-17 fleet could increase \$133.2 million for landing-gear posts and \$5.2 million for trunnion collars. In addition, because of a much higher usage rate than anticipated in the original specifications, support costs could increase as much as \$8 13.5 million for brakes and about \$29 million for tires over the life of the C-17 fleet. The development of an improved main landing-gear tire could result in potential monetary benefits of

approximately \$1.8 million for FYs 1999 through 2005. See the Finding section for details and Appendix E for a summary of potential monetary benefits. Management controls were adequate as they applied to the overall objective.

DTIC

*C-17 Aircraft; Landing Gear; Durability; Aircraft Landing*

19990090017 NASA Dryden Flight Research Center, Edwards, CA USA

Automated Testing Experience of the Linear Aerospike SR-71 Experiment (LASRE) Controller

Larson, Richard R., NASA Dryden Flight Research Center, USA; September 1999; 33p; In English; Test and Evaluation in the Information Age, 21-24 Sep. 1999, Atlanta, GA, USA; Sponsored by Information Technology for European Advancement Contract(s)/Grant(s): RTOP 242-33-02

Report No.(s): NASA/TM-1999-206588; NAS 1.15:206588; H-2380; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

System controllers must be fail-safe, low cost, flexible to software changes, able to output health and status words, and permit rapid retest qualification. The system controller designed and tested for the aerospike engine program was an attempt to meet these requirements. This paper describes (1) the aerospike controller design, (2) the automated simulation testing techniques, and (3) the real time monitoring data visualization structure. Controller cost was minimized by design of a single-string system that used an off-the-shelf 486 central processing unit (CPU). A linked-list architecture, with states (nodes) defined in a user-friendly state table, accomplished software changes to the controller. Proven to be fail-safe, this system reported the abort cause and automatically reverted to a safe condition for any first failure. A real time simulation and test system automated the software checkout and retest requirements. A program requirement to decode all abort causes in real time during all ground and flight tests assured the safety of flight decisions and the proper execution of mission rules. The design also included health and status words, and provided a real time analysis interpretation for all health and status data.

Author

*Aerospike Engines; Controllers; Control Systems Design; Real Time Operation; Scientific Visualization; Performance Tests; Computer Programs*

19990091942 Hellenic Aerospace Industry, Tanagra, Greece

The influences on optimal structural designs of the modelling processes and design concepts

Anastasiadis, P. T., Hellenic Aerospace Industry, Greece; Homlein, H. R. E. M., Daimler-Benz Aerospace A.G., Germany; Krammer, J., Daimler-Benz Aerospace A.G., Germany; Morris, A. J., Cranfield Univ., UK; The Aeronautical Journal; Mar. 1998; Volume 102, No. 1013, pp. 137-150; In English; See also 19990091939; Copyright; Avail: Issuing Activity, Hardcopy

The paper examines the influence on optimal structural designs of changing the design criteria and concepts for an unmanned air vehicle wing, for both single and twin-spar rib configurations. The results indicate that the influence of such factors as panel buckling, aeroelastic efficiency, the number of design variables and the number of ribs can be significant. It is also shown that the best design is given by the twin-spar layout

Author

*Ribs (Supports); Structural Design; Aircraft Structures; Aircraft Design; Structural Weight; Wings; Finite Element Method; Lift; Aeroelasticity*

19990098416 Naval Postgraduate School, Monterey, CA USA

Electrically Propelled Hang Glider for Small Unit Battlefield Mobility

Nolan, Rodney S.; Jun. 1999; 172p; In English

Report No.(s): AD-A366094; No Copyright; Avail: CASI; A08, Hardcopy; A02, Microfiche

On the high speed, info-centric, dispersed battlefield of the future, information dominance will require increased small unit battlefield mobility. The trend of the future will be towards smaller units responsible for scouting, securing, and shaping the battlefield prior to a larger, heavier force being injected at the crucial time and place to decisively engage the enemy. This light scouting, shaping force has a need for some type of vehicle to provide battlefield mobility, insert, extract, escape and evasion, and re-supply. This thesis explores the possibility of using an electrically powered hang glider for small unit battlefield mobility. This platform is not envisioned to replace other means of insertion such as helicopter, rubber boat, etc. This platform is envisioned to provide mobility for these small units once they have been inserted, especially over terrain that is difficult for foot mobility. This thesis discusses the research concept used to conduct the vehicle design. A proposal for an optimal system design using commercially available components is given along with a description of the capabilities and limitations of the platform.

DTIC

*Hang Gliders; Mobility; Propellers; Design Analysis*

19990100658 NASA Langley Research Center, Hampton, VA USA

Airbreathing Hypersonic Vision-Operational-Vehicles Design Matrix

Hunt, James L., NASA Langley Research Center, USA; Pegg, Robert J., NASA Langley Research Center, USA; Petley, Dennis H., NASA Langley Research Center, USA; [1999]; 14p; In English; 1999 World Aviation, 19-21 Oct. 1999, San Francisco, CA, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Report No.(s): Rept-1999-01-5515; Copyright: Avail: Issuing Activity, Hardcopy

This paper presents the status of the airbreathing hypersonic airplane and space-access vision-operational-vehicle design matrix, with emphasis on horizontal takeoff and landing systems being studied at Langley; it reflects the synergies and issues, and indicates the thrust of the effort to resolve the design matrix including Mach 5 to 10 airplanes with global-reach potential, pop-up and dual-role transatmospheric vehicles and airbreathing launch systems. The convergence of several critical systems/technologies across the vehicle matrix is indicated. This is particularly true for the low speed propulsion system for large unassisted horizontal takeoff vehicles which favor turbines and/or perhaps pulse detonation engines that do not require LOX which imposes loading concerns and mission flexibility restraints.

Author

*Air Breathing Engines; Air Breathing Boosters; Booster Rocket Engines; Engine Design; Spacecraft Design; Aircraft Design; Design Analysis; Transatmospheric Vehicles*

19990101885 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. fuer Flugmechanik, Brunswick, Germany

Identification of Non-Linear Derivative Models from Bo 105 Flight Test Data

Rohlf, M., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; The Aeronautical Journal; Jan. 1998; Volume 102, No. 1011, pp. 1-8; In English; 22nd European Rotorcraft Forum, Sep. 1996, Brighton, UK; Sponsored by Royal Aeronautical Society, UK; See also 19990101884

Report No.(s): Paper 2232; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

This paper describes the results of a study focusing on the possibility of identifying nonlinear helicopter models in the time domain. In recent years identification techniques working mainly in the frequency domain were applied to estimate the parameters in helicopter models. Recently, the time domain identification method of DLR was improved to allow the identification of fully nonlinear models. to investigate the applicability of this method to helicopters a nonlinear derivative model with explicit equations for the individual blade flapping angles was formulated. In comparison to the linear derivative models nonlinear models are physically more realistic and are not restricted by small perturbation assumptions. Although, a large number of unknowns had to be determined, a nonlinear model was successfully identified.

Author

*Frequencies; Helicopters; Identifying; Nonlinearity; Time Domain Analysis; Mathematical Models*

19990101886 Queen Mary and Westfield Coll., Dept. of Engineering, London, UK

On the Equations of Motion for an Aircraft with an Internal Moving Load which is then Dropped

Bernstein, L., Queen Mary and Westfield Coll., UK; The Aeronautical Journal; Jan. 1998; Volume 102, No. 1011, pp. 9-24; In English; See also 19990101884

Report No.(s): Paper 2330; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Equations of motion have been developed for the situation in which a substantial load, carried internally by an aircraft, is drawn along a ramp by an retraction parachute and is then dropped. The motion of the load is assumed to remain in the plane of symmetry. The perturbations to the aircraft motion are assumed to be small so that the equations can be linearized following the representation of the aerodynamic out of balance forces using conventional aerodynamic derivatives. The resulting system of six ordinary differential equations consists of the four normally associated with the longitudinally perturbed motion of the aircraft (slightly modified by the reaction forces due to the load), together with two describing the motion of the load. Numerical solutions are presented for a generic aircraft, the investigation examining the effects of a number of different parameters such as the ratio of the mass of the load to that of the aircraft, the length and angle of the ramp, the friction between the load and the ramp and the direction of the parachute extraction force. In addition the effects of employing various control strategies to limit the disturbed motion have also been computed. It was found that the acceleration of the load relative to the aircraft was sensibly constant. In the absence of any resetting of the controls (elevators and throttle), the disturbances computed exceeded those for which the linearizations justified. When the controls were reset, either as the load began to move or as it was jettisoned, to the trim values appropriate to the unloaded aircraft flying at the same speed, the disturbances were reduced, but remained large, the phugoid mode being dominant, the incorporation of various kinds of feedback from the disturbance variables to the elevator was also

investigated and a successful control strategy was identified, that limited the perturbations and minimized the steady-state errors in airspeed and angle of climb

**Author**

*Aerodynamic Balance; Numerical Analysis; Perturbation; Climbing Flight; Mass Distribution; Airdrops; Equations of Motion; Feedback; Dynamic Characteristics*

**19990102880 NASA Wallops Flight Facility, Wallops Island, VA USA**

A Spreadsheet Simulation Tool for Terrestrial and Planetary Balloon Design

Raquea, Steven M., NASA Wallops Flight Facility, USA; [1999]; 1p; In English; No Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

During the early stages of new balloon design and development, it is necessary to conduct many trade studies. These trade studies are required to determine the design space, and aid significantly in determining overall feasibility. Numerous point designs then need to be generated as details of payloads, materials, mission, and manufacturing are determined. To accomplish these numerous designs, transient models are both unnecessary and time intensive. A steady state model that uses appropriate design inputs to generate system-level descriptive parameters can be very flexible and fast. Just such a steady state model has been developed and has been used during both the MABS 2001 Mars balloon study and the Ultra Long Duration Balloon Project. Using Microsoft Excel's built-in iteration routine, a model was built. Separate sheets were used for performance, structural design, materials, and thermal analysis as well as input and output sheets. As can be seen from figure 1, the model takes basic performance requirements, weight estimates, design parameters, and environmental conditions and generates a system level balloon design. Figure 2 shows a sample output of the model. By changing the inputs and a few of the equations in the model, balloons on earth or other planets can be modeled. There are currently several variations of the model for terrestrial and Mars balloons, as well there are versions of the model that perform crude material design based on strength and weight requirements. To perform trade studies, the Visual Basic language built into Excel was used to create an automated matrix of designs. This trade study module allows a three dimensional trade surface to be generated by using a series of values for any two design variables. Once the fixed and variable inputs are defined, the model automatically steps through the input matrix and fills a spreadsheet with the resulting point designs. The proposed paper will describe the model in detail, including current variations. The assumptions, governing equations, and capabilities will be addressed. Detailed examples of the model in practice will also be used.

**Author**

*Balloons; Design Analysis; Structural Design; Tables (Data); Technology Assessment*

**19990103068 National Aerospace Lab., Flight Div., Tokyo, Japan**

Technical Report of National Aerospace Laboratory. Navigation, Guidance, and Control Law and Planning of Flight Experiment for Scaled Supersonic Experimental Airplane, First Report

Suzuki, H.; Jan. 1999; 26p; In Japanese; Portions of this document are not fully legible

Report No.(s): PB99-169575; NAL-TR-1377; No Copyright; Avail: National Technical Information Service (NTIS), Hardcopy

As part of international joint technology development efforts for second-generation supersonic transport, two types of scaled supersonic experimental airplanes, un-powered ones, are under development at the National Aerospace Laboratory (NAL). The results of design of the navigation, guidance, and control law for the un-powered experimental airplane launched by a rocket booster are presented in this paper. The flight capability is assessed based on flight simulations with the designed control system. It is verified that the design control system has the ability to perform the flight plan within first-order accuracy for flight conditions. A flight plan of higher-order accuracy is also proposed based on these results.

**NTIS**

*Control Theory; Flight Plans; Aircraft Guidance; Air Navigation*

**19990103152 NASA Marshall Space Flight Center, Huntsville, AL USA**

Lifting Body Flight Vehicles

Barret, Chris, NASA Marshall Space Flight Center, USA; 1998; 1p; In English, 16-20 Jun. 1998, Houston, TX, USA; Sponsored by Society of Women Engineers; No Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

NASA has a technology program in place to build the X-33 test vehicle and then the full sized Reusable Launch Vehicle, VentureStar. VentureStar is a Lifting Body (LB) flight vehicle which will carry our future payloads into orbit, and will do so at a much reduced cost. There were three design contenders for the new Reusable Launch Vehicle: a Winged Vehicle, a Vertical Lander, and the Lifting Body(LB). The LB design won the competition. A LB vehicle has no wings and derives its lift solely from the shape of its body, and has the unique advantages of superior volumetric efficiency, better aerodynamic efficiency at high angles-of-attack and hypersonic speeds, and reduced thermal protection system weight. Classically, in a ballistic vehicle, drag has

been employed to control the level of deceleration in reentry. In the LB, lift enables the vehicle to decelerate at higher altitudes for the same velocity and defines the reentry corridor which includes a greater cross range. This paper outlines our LB heritage which was utilized in the design of the new Reusable Launch Vehicle, VentureStar. NASA and the U.S. Air Force have a rich heritage of LB vehicle design and flight experience. Eight LB's were built and over 225 LB test flights were conducted through 1975 in the initial LB Program. Three LB series were most significant in the advancement of today's LB technology: the M2-F; HL-10; and X-24 series. The M2-F series was designed by NASA Ames Research Center, the HL-10 series by NASA Langley Research Center, and the X-24 series by the Air Force. LB vehicles are alive again today.

Author

*Hypersonic Speed; Lifting Bodies; Reusable Launch Vehicles; X-33 Reusable Launch Vehicle; Aerodynamic Configurations*

19990103348 General Accounting Office, National Security and International Affairs Div., Washington, DC USA

UNMANNED AERIAL VEHICLES: DoD's Demonstration Approach Has Improved Project Outcomes

Aug. 30, 1999; 16p; In English; Report to the Secretary of Defense.

Report No.(s): AD-A367307; GAO/NSIAD-99-33; No Copyright; Avail: CASI; A03, Handcopy; A01, Microfiche

The Department of Defense (DOD) needs Unmanned Aerial Vehicles (UAV) for surveillance and reconnaissance missions. Since the end of the Vietnam War, DOD began at least nine UAV acquisition programs that were later canceled, spending \$4 billion in the process. (See app. I.) In 1994, as part of its acquisition reform efforts, DOD adopted an Advanced Concept Technology Demonstration (ACTD) strategy for assessing UAVs.<sup>2</sup> We reviewed current UAV projects to determine whether DOD's strategy of conducting ACTDs before developing and producing UAVs provides an improved knowledge base for making acquisition decisions. DOD has completed ACTD projects for the Predator and Outrider UAV systems and has an ongoing ACTD for the Global Hawk UAV. DOD terminated a fourth UAV project, DarkStar, before its ACTD was completed. The ACTD strategy of focusing on mature technology and proving military utility before committing to a UAV has expanded DOD's knowledge base, allowing it to make some well informed acquisition decisions. For example, when DOD began the Predator ACTD in 1994, the Predator was considered technologically mature because its design was based on an existing UAV the Gnat 750. Nevertheless, DOD still required that the Predator's performance be demonstrated. Prototypes of the Predator were deployed in Bosnia in 1995 and 1996, allowing users to determine whether the UAV would meet their needs. Only after this performance data was gathered and analyzed in 1997 was DOD willing to formally commit to the UAV's acquisition.<sup>3</sup> In another case, the ACTD for the DarkStar UAV DOD

DTIC

*Government Procurement; Military Technology; Unmanned Spacecraft; Military Spacecraft*

19990103355 Air Force Academy, CO USA

F-16 Uninhabited Air Combat Vehicles

Thompson, Kenneth E.; Apr. 01, 1998; 82p; In English

Report No.(s): AD-A367242; AU/ACSC/282/1998-04; No Copyright; Avail: CASI; A01, Microfiche; A05, Hardcopy

The US Air Force is Actively pursuing unmanned aerial vehicle programs for surveillance and reconnaissance missions. However, the Air Force has not funded any substantial research into bomb or missile carrying "lethal" UAV's, despite the recommendations of the USAF scientific board's New World Vistas, DARPA, and the Air Force 2025 project. With budget constraints and a reluctant to transition to an unmanned combat force, new advance technologies UCAVs are decades from operational status. by modifying the multi-role F-16 fighter into an unmanned aircraft, the USAF can quickly provide a cost-effective interim UCAV. Lockheed Martin has suggested the modification of "boneyard" non-flying F-16 A-models into UCAVs. An investigation of this idea yielded several limitations and concerns that led to the formulation of an alternative F-16 UCAV proposal. Many of the limitations, concerns and costs associated with the Lockheed Martin F-16A proposal are eliminated or reduced by modifying currently flying block 40 and 50 F-16Cs and operational squadrons. With the addition of remote control equipment, a few squadron jets are converted into "dual role" aircraft. The selected dual role F-16Cs can continue to fly as normal "manned" aircraft or, if needed as unmanned remotely piloted UCAVs. Converting a few block 40 LANTIRN laser targeting pod equipped and block 50 HARM targeting system equipped F-16Cs in operational squadrons to dual role UCAVs will quickly provide a cost effective and capable interim unmanned military option. With low modification costs, no new infrastructure requirements, and no need for additional pilots or support personnel, the USAF should immediately start the developments, testing and conversion of a few F-16Cs into dual role UCAVs. As an interim unmanned military option, the F-16C UCAV will provide valuable insights and lessons or future advanced technology UCAV development and operations.

DTIC

*F-16 Aircraft; Pilotless Aircraft; Remotely Piloted Vehicles*

19990103619 Naval Surface Warfare Center, Carderock Div., Bethesda, MD USA

Dynamic Effects on Propeller Blade Section Lift, Drag, and Pitching Moment Coefficients *Final Report*

Shen, Young T.; Fuhs, Donald; Aug. 1999; 62p; In English

Contract(s)/Grant(s): Proj-R2332

Report No.(s): AD-A367313; CRDKNSWC/HD-1205-05; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The Propeller Force Module (PFM) uses the blade element/moment theory to predict propeller forces during maneuvers. A typical inflow angle distribution is studied. The blade sections will encounter spatial and temporal variations in angles of attack. Theories to calculate unsteady effects on section lift, drag, and pitching moment coefficients are formulated and presented in this report. Using the classic approach developed in aerodynamics, the section lift and pitching moment are expressed in circulatory and non-circulatory solutions. The non-circulatory solution is found to be a universal function independent of the type of motion. The circulatory solution depends heavily on the type of motion. In the case of ramp-up and ramp-down motions simulating blade sections experiencing angle of attack variations when maneuvering, an analytical solution is obtained for the circulatory lift. Empirical formula are developed to calculate the delay in stall angle due to unsteady motion. The classic aerodynamic theories assume the flow to be potential which give zero drag. Instead, Leishman's mathematical model assuming a loss of full suction pressure recovery at the leading edge due to viscous effect is adopted in this report to calculate the dynamic drag. The theories are compared with experimental measurements by Francis and Keesee, and by Ham and Garelick with encouraging results.

DTIC

*Aerodynamic Drag; Lift; Pitch (Inclination); Pitching Moments; Predictions; Dynamic Response; Propeller Blades; Angle of Attack; Leading Edges*

19990104323 NASA Dryden Flight Research Center, Edwards, CA USA

Summary of Inlet Characteristics of the F/A-18A High Alpha Research Vehicle

Walsh, Kevin, NASA Dryden Flight Research Center, USA; Steenken, William, General Electric Co., USA; Williams, John, General Electric Co., USA; July 1998; In English; 34th; Propulsion, 13-15 Jul. 1998, Cleveland, OH, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; Diskette: 1 3.5-inch DSHD diskette

Contract(s)/Grant(s): RTOP 529-31-04-00-37

Report No.(s): H-2260; AIAA Paper 98-3713; NONP-NASA-DK-1998358197; Copyright; Avail: Issuing Activity, Hardcopy, Microfiche, Diskette

Effects of high-angle-of-attack flight on aircraft inlet aerodynamic characteristics were investigated at NASA Dryden Flight Research Center as part of NASA's High Alpha Technology Program. The highly instrumented F/A-18A High Alpha Research Vehicle was used for this research. A newly designed inlet total-pressure rake was installed in front of the right-hand F404-GE-400 engine to measure inlet recovery and distortion characteristics. Objectives included: (1) determining the inlet total-pressure characteristics at steady high-angle-of-attack conditions; (2) assessing if inlet distortion is significantly different between rapid angle-of-attack maneuvers and corresponding steady aerodynamic conditions; (3) assessing inlet characteristics during aircraft departures; (4) providing data for developing and verifying computational fluid dynamic codes; and (5) calculating engine airflow using four methods for comparison with a reference method. This paper describes the results obtained from this investigation. These data and the associated database were rigorously validated to establish the foundation for understanding inlet characteristics at high angle of attack.

Author

*Aerodynamic Characteristics; Air Flow; Angle of Attack; Computational Fluid Dynamics; Engine Inlets; Inlet Pressure; Takeoff; Inlet Flow; Air Intakes; Turbulence; Aerodynamic Stalling*

19990104609 Naval Postgraduate School, Monterey, CA USA

Design and Prototype Development of a Wireless Power Transmission System for a Micro Air Vehicle (MAV)

Vitale, Robert L.; Jun. 1999; 193p; In English

Report No.(s): AD-A367272; No Copyright; Avail: CASI; A09, Hardcopy; A03, Microfiche

Microwave radiation at 1.0 GHz and 1.3 GHz is used to demonstrate remote powering of a micro air vehicle (MAV). Several prototype microwave rectifier systems were fabricated in microstrip using EEsoft(registered) computer aided engineering (CAE) software to assist in their design. Radio frequency (RF) parameters of the rectifiers were measured on a vector network analyzer. RF-to-DC conversion efficiency was measured for several designs and with various circuit loads consisting of lumped elements and DC motors. A peak RF-to-DC conversion efficiency of 33 percent was achieved. MAV antenna designs were investigated by simulating 68 geometries using the GNEC (registered) numerical electromagnetics computer program. Two prototype MAVs were assembled, each consisting of microwave rectifier, antenna and a miniature DC motor. It was demonstrated that a 1.8-Watt,

1.3-GHz microwave signal could power the DC motor at free space distance of 30 inches from transmitting antenna to prototype MAV. Greater operating distances are proposed by using higher transmitting power and antenna gain.

DTIC

*Prototypes; Electric Power Transmission; Transmission Lines; Antenna Design; Microwave Antennas; Microwaves*

19990105689 Georgia Tech Research Inst., Aerospace, Transportation and Advanced Systems Lab., Atlanta, GA USA

Additional Development and Systems Analyses of Pneumatic Technology for High Speed Civil Transport Aircraft. *Final Report, 6 Apr. 1998 - 5 Jul. 1999*

Englar, Robert J., Georgia Tech Research Inst., USA; Willie, F. Scott, Georgia Tech Research Inst., USA; Lee, Warren J., Georgia Tech Research Inst., USA; Oct. 03, 1999; 83p; In English; Original contains color illustrations

Contract(s)/Grant(s): NAG1-2051; GTRI Proj. A-5676; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

In the Task 1 portion of this NASA research grant, configuration development and experimental investigations have been conducted on a series of pneumatic high-lift and control surface devices applied to a generic High Speed Civil Transport (HSCT) model configuration to determine their potential for improved aerodynamic performance, plus stability and control of higher performance aircraft. These investigations were intended to optimize pneumatic lift and drag performance; provide adequate control and longitudinal stability; reduce separation flowfields at high angle of attack; increase takeoff/climbout lift-to-drag ratios; and reduce system complexity and weight. Experimental aerodynamic evaluations were performed on a semi-span HSCT generic model with improved fuselage fineness ratio and with interchangeable plain flaps, blown flaps, pneumatic Circulation Control Wing (CCW) high-lift configurations, plain and blown canards, a novel Circulation Control (CC) cylinder blown canard, and a clean cruise wing for reference. Conventional tail power was also investigated for longitudinal trim capability. Also evaluated was unsteady pulsed blowing of the wing high-lift system to determine if reduced pulsed mass flow rates and blowing requirements could be made to yield the same lift as that resulting from steady-state blowing. Depending on the pulsing frequency applied, reduced mass flow rates were indeed found able to provide lift augmentation at lesser blowing values than for the steady conditions. Significant improvements in the aerodynamic characteristics leading to improved performance and stability/control were identified, and the various components were compared to evaluate the pneumatic potential of each. Aerodynamic results were provided to the Georgia Tech Aerospace System Design Lab. to conduct the companion system analyses and feasibility study (Task 2) of these concepts applied to an operational advanced HSCT aircraft. Results and conclusions from these experimental evaluations are presented herein, as are recommendations for further development and follow-on investigations. Also provided as an Appendix for reference are the basic results from the previous pneumatic HSCT investigations.

Derived from text

*Pneumatics; Civil Aviation; Control Surfaces; Aerodynamic Characteristics; Wind Tunnel Tests; Canard Configurations; Supersonic Transports; Lift Augmentation; Systems Analysis*

19990105723 Georgia Inst. of Tech., Aerospace Systems Design Lab., Atlanta, GA USA

System Analyses of Pneumatic Technology for High Speed Civil Transport Aircraft. *Final Report, 6 Apr. 1998 - 5 Jul. 1999*

Mavris, Dimitri N., Georgia Inst. of Tech., USA; Tai, Jimmy C., Georgia Inst. of Tech., USA; Kirby, Michelle M., Georgia Inst. of Tech., USA; Roth, Bryce A., Georgia Inst. of Tech., USA; Oct. 03, 1999; 134p; In English

Contract(s)/Grant(s): NAG1-2051; GTRI Proj. A-5676; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

The primary aspiration of this study was to objectively assess the feasibility of the application of a low speed pneumatic technology, in particular Circulation Control (CC) to an HSCT concept. Circulation Control has been chosen as an enabling technology to be applied on a generic High Speed Civil Transport (HSCT). This technology has been proven for various subsonic vehicles including flight tests on a Navy A-6 and computational application on a Boeing 737. Yet, CC has not been widely accepted for general commercial fixed-wing use but its potential has been extensively investigated for decades in wind tunnels across the globe for application to rotorcraft. More recently, an experimental investigation was performed at Georgia Tech Research Institute (GTRI) with application to an HSCT-type configuration. The data from those experiments was to be applied to a full-scale vehicle to assess the impact from a system level point of view. Hence, this study attempted to quantitatively assess the impact of this technology to an HSCT. The study objective was achieved in three primary steps: 1) Defining the need for CC technology; 2) Wind tunnel data reduction; 3) Detailed takeoff/landing performance assessment. Defining the need for the CC technology application to an HSCT encompassed a preliminary system level analysis. This was accomplished through the utilization of recent developments in modern aircraft design theory at Aerospace Systems Design Laboratory (ASDL). These developments include the creation of techniques and methods needed for the identification of technical feasibility show stoppers. These techniques and methods allow the designer to rapidly assess a design space and disciplinary metric enhancements to enlarge or improve the design space. The takeoff and landing field lengths were identified as the concept "show-stoppers". Once the need for CC was established, the actual application of data and trends was assessed. This assessment entailed a reduction of the wind tunnel data from the

experiments performed by Mr. Bob Englar at the GTRI. Relevant data was identified and manipulated based on the required format of the analysis tools utilized. Propulsive, aerodynamic, duct sizing, and vehicle sizing investigations were performed and information supplied to a detailed takeoff and landing tool. From the assessments, CC was shown to improve the low speed performance metrics, which were previously not satisfied. An HSCT with CC augmentation does show potential for full-scale application. Yet, an economic assessment of an HSCT with and without CC showed that a moderate penalty was incurred from the increased RDT&E costs associated with developing the CC technology and slight increases in empty weight.

Derived from text:

*Pneumatics; Civil Aviation; Circulation Control Airfoils; Aircraft Design; Technology Utilization; Supersonic Transports; Feasibility Analysis; Aircraft Performance; Data Reduction*

## 06 AIRCRAFT INSTRUMENTATION

*Includes cockpit and cabin display devices; and flight instruments.*

19990088123 Illinois Univ., Urbana-Champaign, IL USA

Display of Predictor Reliability on a Cockpit Display of Traffic Information

Gempler, Keith Stewart, Illinois Univ., USA; Jul. 28, 1999; 83p; In English

Report No.(s): AD-A366236; AFIT-FY99-178; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

To improve the availability of information to the pilot concerning other traffic, the concept of a Cockpit Display of Traffic Information (CDTI) has been developed through efforts by NASA. These displays make information about the pilot's own aircraft and others in the flying environment visible, enabling pilots see potential conflicts and avoid them with the most effective maneuvering. These displays support the challenge of free flight, where the pilot becomes more autonomous in deciding exact routing of his aircraft between destinations. With this autonomy from Air Traffic Control, comes an increase in requirements for the pilot to be aware of the position of both his own aircraft and other traffic that may pose a conflict. Therefore, information about own-ship and other-ship's current and future positions must be displayed so the pilot can choose a course, speed, and altitude that will maintain safe separation from other aircraft, to increase the efficiency of maneuvers (saving costs in terms of fuel and delays) the pilot will need to make maneuvering decisions based on predicted aircraft separation well in advance of a possible conflict. The development of this CDTI system has raised several psychological issues, many of which have already been investigated. DTIC

*Safety; Reliability Analysis; Air Traffic Control; Cockpits; Display Devices*

19990102209 NASA Marshall Space Flight Center, Huntsville, AL USA

1998 Digital Avionics Highlights

Polites, Michael E., NASA Marshall Space Flight Center, USA; December 1998; 1p; In English; Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

This article summarizes the highlights of recent events and developments in digital avionics in space, aircraft, and weapons. The article is about 1,200 words long. Information for the article was collected from members of the Digital Avionics Technical Committee of the American Institute of Aeronautics and Astronautics. This information was previously cleared by the members' parent organization. Information for the article was also gathered from Aviation Week and Space Technology and similar sources.

Author

*Avionics; Summaries*

19990102859 NASA Marshall Space Flight Center, Huntsville, AL USA

Application of Reconfigurable Avionics for the Bantam Launch Vehicle

Wallace, Shawn, NASA Marshall Space Flight Center, USA; Wilkerson, DeLisa, NASA Marshall Space Flight Center, USA; 1999; In English; 18th; Digital Avionics Systems, 23-29 Oct. 1999, Saint Louis, MO, USA; Sponsored by American Inst. of Aeronautics and Astronautics; Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

The modern market is placing increasing pressure on launch costs. This is particularly true for small university science payloads, where the cost of the experiment itself is relatively low, and the launch frequency is potentially very high. It is the stated goal of the Bantam Program to dramatically reduce the costs of launching this class of payloads. This is a goal that will require that the avionics not only be reduced in production costs, but also in maintenance and operation costs, because the Bantam vehicle is envisioned as a reusable launch system. However, the costs of avionics is a relatively small fraction of the overall cost of launching a payload, and a simple reduction in the avionics costs will not immediately realize the necessary gains. Instead, to

reduce the total system launch costs, it is also necessary to improve avionics performance. Only by reducing weight, volume, and power, while enhancing computational capability can the avionics be used to address the system-level cost reduction requirements. The National Aeronautics and Space Administration is currently pursuing technology development tasks, in order to support the Bantam requirements. One technology task is to develop a low-cost, high-performance reconfigurable avionics core unit. In addition to providing low cost and high performance, the use of reconfigurability will be used to explore the options of accommodating multiple launch configurations, and addressing such areas as redundancy management, single-event upset immunity, and low maintenance. This paper will address how emerging developments in reconfigurable avionics can be used to meet these challenges.

**Author**

*Avionics; Cost Reduction; Costs; Launch Costs; NASA Programs; Reusable Spacecraft; Configuration Management*

**19990102985 Institute for Human Factors TNO, Soesterberg, Netherlands**

Advanced Cockpit Displays for Target Acquisition *Final Report Geavanceerde cockpit displays t.h.v. detectie en identificatie van doelen*

deVries, S. C., Institute for Human Factors TNO, Netherlands; vanBreda, L., Institute for Human Factors TNO, Netherlands; Bakker, N. H., Institute for Human Factors TNO, Netherlands; Apr. 14, 1999; 40p; In English

Contract(s)/Grant(s): A95/KLu/341; TNO Proj. 788.1

Report No.(s): TD-99-0033; TM-99-A028; Copyright; Avail: Issuing Activity, Hardcopy

In a flight simulator experiment the use of various tactical displays in a target search and identify task was examined. Four display conditions were investigated: no tactical information, tactical information on a Head Down Display (HDD), tactical information on a HDD and on a Head Up Display (HUD), and tactical information on a HDD and on a Head Mounted Display (HMD). The scenarios used (flying a route indicated by a 'tunnel-in-the-sky' display with targets close to this route) did not exploit the full potential of the HMD. They were chosen to enable fair comparison of the displays. The results show that target detection and identification accuracy is slightly lower when the tactical displays are used. However, targets were detected at much larger distances. This is an indication that the tactical displays, and especially the HMD, enabled the pilots to report their detections considerably earlier than in the absence of tactical information. Flying performance with the HMD was less than without HMD, though. A probable cause is the visual interference of the HMD symbology with other avionics. An alternative explanation is that the HMD enabled the pilots to acquire tactical information without looking in the cockpit, giving more time for targets searching. This means that they had less time to keep an eye on the route display, leading to larger course deviations.

**Author**

*Cockpits; Display Devices; Target Acquisition; Research*

**19990102999 National Aerospace Lab., Flight Div., Tokyo, Japan**

Cockpit Procedural Advisory System Utilizing Flight Phase Estimation

Tanaka, K.; Funabiki, K.; Muraoka, K.; Jan. 1999; 30p; In Japanese; Portions of this document are not fully legible

Report No.(s): PB99-164949; NAL-TR-1381; Copyright; Avail: National Technical Information Service (NTIS), Hardcopy

This study deals with a proposed advisory display against cockpit procedural deviations by using autonomously estimated flight phases. Advisory systems such as a landing gear horn are of interest in this study as reactive means to protect from the consequences of slips or mistakes. The proposed system provided advisory information regarding control devices and switches critical in each flight phase. To this end, the flight phase at each instant was estimated by using the limitations of transitions from one flight phase to another. The system was implemented in a flight simulator of a glass cockpit environment, where advisory information was presented to flight crew members in an integrated altering display. An operational simulation beginning from cockpit preparations to engine shutdown was conducted, and showed that the advisory system functioned against procedural deviations appropriately and timely. However, it was found that the flight phase transition needs to be improved after a missed approach, and that the display information needs to be integrated with the existing warning system. Potential implementation of a proposed system in a future warning system or a future flight management system was suggested.

NTIS

*Cockpits; Flight Management Systems; Flight Instruments; Flight Control; Display Devices*

**19990105883 NASA Dryden Flight Research Center, Edwards, CA USA**

Flush Airdata Sensing (FADS) System Calibration Procedures and Results for Blunt Forebodies

Cobleigh, Brent R., NASA Dryden Flight Research Center, USA; Whitmore, Stephen A., NASA Dryden Flight Research Center, USA; Haering, Edward A., Jr., NASA Dryden Flight Research Center, USA; Borer, Jerry, NASA Johnson Space Center, USA; Roback, V. Eric, NASA Langley Research Center, USA; November 1999; 32p; In English; 9th; Space Planes and Hypersonic

Systems and Technologies, 1-5 Nov. 1999, Norfolk, VA, USA

Contract(s)/Grant(s): RTOP 242-33-02-00-23

Report No.(s): NASA/TP-1999-209012; NAS 1.60:209012; H-2379; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Blunt-forebody pressure data are used to study the behavior of the NASA Dryden Flight Research Center flush airdata sensing (FADS) pressure model and solution algorithm. The model relates surface pressure measurements to the airdata state. Spliced from the potential flow solution for uniform flow over a sphere and the modified Newtonian impact theory, the model was shown to apply to a wide range of blunt-forebody shapes and Mach numbers. Calibrations of a sphere, spherical cones, a Rankine half body, and the F-14, F/A-18, X-33, X-34, and X-38 configurations are shown. The three calibration parameters are well-behaved from Mach 0.25 to Mach 5.0, an angle-of-attack range extending to greater than 30 deg, and an angle-of-sideslip range extending to greater than 15 deg. Contrary to the sharp calibration changes found on traditional pitot-static systems at transonic speeds, the FADS calibrations are smooth, monotonic functions of Mach number and effective angles of attack and sideslip. Because the FADS calibration is sensitive to pressure port location, detailed measurements of the actual pressure port locations on the flight vehicle are required and the wind-tunnel calibration model should have pressure ports in similar locations. The procedure for calibrating a FADS system is outlined.

Author

Procedures; Calibrating; Forebodies; Mathematical Models; Algorithms; Potential Flow; Pressure Measurement; Newton Theory

## 07 AIRCRAFT PROPULSION AND POWER

*Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.*

19990092373 Boeing Commercial Airplane Co., Seattle, WA USA

An Evaluation of Aircraft Emissions Inventory Methodology by Comparisons with Reported Airline Data

Daggett, D. L., Boeing Commercial Airplane Co., USA; Sutkus, D. J., Boeing Commercial Airplane Co., USA; DuBois, D. P., Boeing Commercial Airplane Co., USA; Baughcum, S. L., Boeing Commercial Airplane Co., USA; September 1999; 90p; In English

Contract(s)/Grant(s): NAS1-20267

Report No.(s): NASA/CR-1999-209480; Rept-99B00077; NAS 1.26:209480; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

This report provides results of work done to evaluate the calculation methodology used in generating aircraft emissions inventories. Results from the inventory calculation methodology are compared to actual fuel consumption data. Results are also presented that show the sensitivity of calculated emissions to aircraft payload factors. Comparisons of departures made, ground track miles flown and total fuel consumed by selected air carriers were made between U.S. Dept. of Transportation (DOT) Form 41 data reported for 1992 and results of simplified aircraft emissions inventory calculations. These comparisons provide an indication of the magnitude of error that may be present in aircraft emissions inventories. To determine some of the factors responsible for the errors quantified in the DOT Form 41 analysis, a comparative study of in-flight fuel flow data for a specific operator's 747-400 fleet was conducted. Fuel consumption differences between the studied aircraft and the inventory calculation results may be attributable to several factors. Among these are longer flight times, greater actual aircraft weight and performance deterioration effects for the in-service aircraft. Results of a parametric study on the variation in fuel use and NO<sub>x</sub> emissions as a function of aircraft payload for different aircraft types are also presented.

Author

Exhaust Emission; Inventory Controls; Data Acquisition; Boeing 747 Aircraft; Fuel Consumption; Aircraft Fuels; Inventories

19990095609 Pratt and Whitney Aircraft, East Hartford, CT USA

Low Noise Research Fan Stage Design *Final Report*

Hobbs, David E., Pratt and Whitney Aircraft, USA; Neubert, Robert J., Pratt and Whitney Aircraft, USA; Malmborg, Eric W., Pratt and Whitney Aircraft, USA; Philbrick, Daniel H., Pratt and Whitney Aircraft, USA; Spear, David A., Pratt and Whitney Aircraft, USA; March 1995; 60p; In English

Contract(s)/Grant(s): NAS3-26618; RTOP 538-03-11

Report No.(s): NASA-CR-195382; E-9125; NAS 1.26:195382; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

This report describes the design of a Low Noise ADP Research Fan stage. The fan is a variable pitch design which is designed at the cruise pitch condition. Relative to the cruise setting, the blade is closed at takeoff and opened for reverse thrust operation. The fan stage is a split flow design with fan exit guide vanes and core stators. This fan stage design was combined with a nacelle and engine core duct to form a powered fan/nacelle, subscale model. This model is intended for use in aerodynamic performance, acoustic and structural testing in a wind tunnel. The model has a 22-inch outer fan diameter and a hub-to-top ratio of 0.426 which permits the use of existing NASA fan and cowl force balance designs and rig drive system. The design parameters were selected to permit valid acoustic and aerodynamic comparisons with the PW 17-inch rig previously tested under NASA contract. The fan stage design is described in detail. The results of the design axisymmetric analysis at aerodynamic design condition are included. The structural analysis of the fan rotor and attachment is described including the material selections and stress analysis. The blade and attachment are predicted to have adequate low cycle fatigue life, and an acceptable operating range without resonant stress or flutter. The stage was acoustically designed with airfoil counts in the fan exit guide vane and core stator to minimize noise. A fan-FEGV tone analysis developed separately under NASA contract was used to determine these airfoil counts. The fan stage design was matched to a nacelle design to form a fan/nacelle model for wind tunnel testing. The nacelle design was developed under a separate NASA contract. The nacelle was designed with an axisymmetric inlet, cowl and nozzle for convenience in testing and fabrication. Aerodynamic analysis of the nacelle confirmed the required performance at various aircraft operating conditions.

Author

*Low Noise; Turbofans; Fan Blades; Ducted Fans; Design Analysis; Stress Analysis; Structural Design; Structural Analysis*

19990095795 General Electric Co., Aircraft Engines, Cincinnati, OH USA

Multistage Simulations of the GE90 Turbine *Final Report*

Turner, Mark G., General Electric Co., USA; Vitt, Paul H., ASE Technologies, Inc., USA; Topp, David A., General Electric Co., USA; Saeidi, Sohrab, General Electric Co., USA; Hunter, Scott D., General Electric Co., USA; Dailey, Lyle D., General Electric Co., USA; Beach, Timothy A., DYNACS Engineering Co., Inc., USA; September 1999; 16p; In English; Gas Turbine and Aeroengine Congress, 7-10 Jun. 1999, Indianapolis, IN, USA; Sponsored by American Society of Mechanical Engineers, USA Contract(s)/Grant(s): NAS3-26617; NAS3-27720; RTOP 509-10-11

Report No.(s): NASA/CR-1999-209311; E-11880; NAS 1.26:209311; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The average passage approach has been used to analyze three multistage configurations of the GE90 turbine. These are a high pressure turbine rig, a low pressure turbine rig and a full turbine configuration comprising 18 blade rows of the GE90 engine at takeoff conditions. Cooling flows in the high pressure turbine have been simulated using source terms. This is the first time a dual-spool cooled turbine has been analyzed in 3D using a multistage approach. There is good agreement between the simulations and experimental results. Multistage and component interaction effects are also presented. The parallel efficiency of the code is excellent at 87.3% using 121 processors on an SGI Origin for the 18 blade row configuration. The accuracy and efficiency of the calculation now allow it to be effectively used in a design environment so that multistage effects can be accounted for in turbine design.

Author

*Turbines; Turbine Engines; Engine Parts; Turbine Blades; Compressor Blades*

19990097455 Purdue Univ., School of Mechanical Engineering, West Lafayette, IN USA

University Research Initiative for Rotorcraft Engine Unsteady Aerodynamics *Final Report*

Fleeter, Sanford, May 1998; 27p; In English

Contract(s)/Grant(s): DAAL03-92-G-0119

Report No.(s): AD-A365263; ARO-30342.1-EG-URI; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Two problems driven by unsteady flow phenomena critical to advanced rotorcraft engines are addressed. (1) The surge line must be extended to higher pressure ratios (2) Blade rows are susceptible to flow induced vibrations. The onset and control of instability in low and high speed centrifugal compressors was addressed. Low speed experiments obtained unique detailed flow field data during a stall event. Also, both passive dynamic and active control techniques for the suppression of rotating stall were investigated. A unique facility representative of a high speed, high pressure ratio centrifugal compressor was developed in cooperation with Allison Gas Turbines. Experiments were then performed to characterize the surge initiation process, including transient operation and passive control. Experiments addressed the combined and simultaneous motion and gust induced unsteady aerodynamic response of compressor rotor blades from both flutter and forced response perspectives. Also, PIV was used to obtain a time history of the velocity field over a chordwise bending oscillating cascaded airfoil at design and off-design. Models were developed to analyze the unsteady flow, including separation, through an oscillating cascade and also the feasibility of active

suppression of nonlinear stall flutter using piezoelectric actuators, including limit cycle, chaotic and quasi-periodic separated flow induced vibrations.

DTIC

*Aerodynamic Characteristics; Rotary Wing Aircraft; Unsteady Aerodynamics*

10990097978 Allied-Signal Engines, Phoenix, AZ USA

Forced Mixer Nozzle Optimization *Final Report*

Sheoran, Yogi, Allied-Signal Engines, USA; Hoover, Robert, Allied-Signal Engines, USA; Schuster, William, Allied-Signal Engines, USA; Anderson, Morris, Allied-Signal Engines, USA; Weir, Donald S., Allied-Signal Engines, USA; September 1999; 62p; In English; Original contains color illustrations

Contract(s)/Grant(s): NAS3-27483; RTOP 538-03-11

Report No.(s): NASA/CR-1999-209160; E-11723; NAS 1.26:209160; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

Computational fluid dynamic (CFD) and computational acoustic analyses (CAA) were performed for a TFE731-40 compound nozzle, a TFE731-60 mixer nozzle and an Energy Efficient Engine (E<sup>sup</sup> 3) mixer nozzle for comparison with available data. The CFD analyses were performed with a three dimensional, Navier-Stokes solution of the flowfield on an unstructured grid using the RAMPANT program. The CAA analyses were performed with the NASA Glenn MGB program using a structured grid. A successful aerodynamic solution for the TFE731-40 compound nozzle operating statically was obtained, simulating an engine operating on a test stand. Analysis of the CFD results of the TFE731-40 with the MGB program produced predicted sound power levels that agree quite well with the measured data from full-scale static engine tests. Comparison of the predicted sound pressure with the data show good agreement near the jet axis, but the noise levels are overpredicted at angles closer to the inlet. The predicted sound power level for the TFE731-60 did not agree as well with measured static engine data as the TFE731-40. Although a reduction in the predicted noise level due to the mixed flow was observed, the reduction was not as significant as the measured data. The analysis of the V2 mixer from the E<sup>sup</sup> 3 study showed that peak temperatures predicted in the mixer exit flowfield were within 5 percent of the values measured by the exit probes. The noise predictions of the V2 mixer nozzle tended to be 3-5 dB higher in peak noise level than the measurements. In addition, the maximum frequency of the noise was also overpredicted. An analysis of the 3 candidate mixer nozzle configurations demonstrated the feasibility of using centerbody lobes and porosity to improve mixing efficiency. A final configuration was designed with a predicted thermal mixing efficiency that was 5 percent higher than the 3 candidate mixers. The results of the MGB noise calculations show that the final design will exceed the design goal of a 3 dB reduction in noise as compared to the baseline TFE731-40.

Author

*Computational Fluid Dynamics; Navier-Stokes Equation; Structured Grids (Mathematics); Unstructured Grids (Mathematics); Mixers; Exhaust Nozzles; Jet Engines*

10990097979 NASA Dryden Flight Research Center, Edwards, CA USA

Selected Performance Measurements of the F-15 Active Axisymmetric Thrust-Vectoring Nozzle

Orme, John S., NASA Dryden Flight Research Center, USA; Sims, Robert L., NASA Dryden Flight Research Center, USA; Nov. 08, 1998; 12p; In English; International Symposium on Airbreathing Engines (ISABE), 5-10 Sep. 1999, Florence, Italy; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Flight tests recently completed at the NASA Dryden Flight Research Center evaluated performance of a hydromechanically vectored axisymmetric nozzle onboard the F-15 ACTIVE. A flight-test technique whereby strain gages installed onto engine mounts provided for the direct measurement of thrust and vector forces has proven to be extremely valuable. Flow turning and thrust efficiency, as well as nozzle static pressure distributions were measured and analyzed. This report presents results from testing at an altitude of 30,000 ft and a speed of Mach 0.9. Flow turning and thrust efficiency were found to be significantly different than predicted, and moreover, varied substantially with power setting and pitch vector angle. Results of an in-flight comparison of the direct thrust measurement technique and an engine simulation fell within the expected uncertainty bands. Overall nozzle performance at this flight condition demonstrated the F100-PW-229 thrust-vectoring nozzles to be highly capable and efficient.

Author

*F-15 Aircraft; Thrust Vector Control; Nozzle Design; Aircraft Stability; Aircraft Control; Controllability; Maneuverability; Stability Augmentation*

19990101888 Cranfield Univ., School of Mechanical Engineering, Bedford, UK

Variable Cycle Jet Engines for a Mach 2.7 Supersonic Civil Transport

Aleid, L., Cranfield Univ., UK; Pilidis, P., Cranfield Univ., UK; The Aeronautical Journal; Jan. 1998; Volume 102, No. 1011, pp. 31-36; In English; See also 19990101884

Report No.(s): Paper 2352; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

The aim of the work outlined in this paper is to compare three different variable cycle jet engine concepts for future Supersonic Transports (SST's). These engines are: the turbofan-turbojet, the mid tandem fan engine and the double bypass engine. The comparison is carried out on the basis of uninstalled and installed performance, handling and sizing issues. The preliminary analysis compares SFC, size, variable geometry, and cycle changes for each engine. The installed performance was estimated by calculating the air friction, the pre-entry and the after body drags, together with the wave drag due to the shock waves. A sizing calculation was carried out for the whole nacelle. The uninstalled and installed fuel bill for two standard missions is also estimated. These preliminary results indicate that the turbofan-turbojet and the mid-tandem fan engines are quite similar in terms of general suitability. The mid-tandem fan appears to be an attractive proposition from the point of view of sizing, however this comes with a small penalty in fuel consumption. The present double bypass engine was found to be least attractive for the application, although the differences are small.

Author

*Engine Design; Supersonic Transports; Turbofan Engines; Turbojet Engines; Variable Cycle Engines; Nozzle Efficiency; Cruising Flight*

19990101889 Queensland Univ., Dept. of Mechanical Engineering, Brisbane, Australia

Experiments on Cruise Propulsion with a Hydrogen Scramjet

Stalker, R. J., Queensland Univ., Australia; Paull, A., Queensland Univ., Australia; The Aeronautical Journal; Jan. 1998; Volume 102, No. 1011, pp. 37-43; In English; See also 19990101884

Contract(s)/Grant(s): NAGw-674

Report No.(s): Paper 2250; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Measurement of drag have been made in a shock tunnel on a simple integrated vehicle engine combination for hypersonic cruise with hydrogen scramjet propulsion. The test flow Mach number was 6.4, and the velocity was 2.45 km<sup>2</sup>exp<sup>-1</sup>. Zero Drag, which is the necessary condition for cruise, was achieved as the equivalence ratio approached one. It was found that an analysis using established aerodynamic concept was adequate for predicting drag in the case of no combustion. When combustion occurred results of direct connect experiments provided was qualitative guide to the measured levels of drag, and indicated that thrust nozzle combustion was taking place. An heuristic analysis is used to point to the important effect this may have on propulsive lift.

Author

*Supersonic Combustion Ramjet Engines; Hypersonic Flight; Cruising Flight; Hypersonic Flow; Wind Tunnel Tests; Hydrogen Fuels; Chemical Propulsion; Aerodynamic Drag*

19990101890 Loughborough Univ. of Technology, Dept. of Aeronautical and Automotive Engineering and Transport Studies, UK

Studies into Hail Ingestion of Turbofan Engines using a Rotating Fan and Spinner Assembly

Pan, H., Loughborough Univ. of Technology, UK; Render, P. M., Loughborough Univ. of Technology, UK; The Aeronautical Journal; Jan. 1998; Volume 102, No. 1011, pp. 45-51; In English; See also 19990101884

Report No.(s): Paper 2254; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Simulated hailstones were made to impact on the rotating spinner and fan assembly of a Williams FJ44 engine. The mass distribution of ice behind the fan was determined by use of a suction tube technique. Suction was added to ensure that the tube did not affect the flow through the fan assembly. The strong air flow behind the fan meant that the ice caught by the tube melted and evaporated, this made it difficult to accurately determine the mass distribution of ice. As a result the simulated hailstones were made from a water-salt solution so that the weight of salt residue could be measured after the water had evaporated, and hence the amount of ice caught was determined. A parametric study into the hail ingestion characteristics of the fan assembly was carried out. The parameters studied included the radial position of the impact point, the rotational speed of the fan and the position of the splitter between the core engine and bypass duct. The results showed that the impact position had a major effect on the overall ice distribution, which was determined by the combination of blade geometry at the impact point and the rotational speed. The splitter position was shown to have a significant effect on the amount of ice passing into the bypass duct.

Author

*Hail; Ingestion (Engines); Rotation; Spinners; Turbofan Engines; Splitting*

19990102970 Research and Technology Organization, Applied Vehicle Technology Panel, Neuilly-sur-Seine, France

Planar Optical Measurement Methods for Gas Turbine Components *Méthodes de Mesure Optiques Planaires Pour Organes de Turbomoteurs*

September 1999, 148p; In English, 16-17 Sep. 1999, Cranfield, Cleveland, OH, UK, USA; See also 19990102971 through 19990102977; Original contains color illustrations

Report No.(s): RTO-EN-6; AC/323(AVT)TP/20; ISBN 92-837-1019-3; Copyright Waived; Avail: CASE: A07, Hardcopy: A02, Microfiche

This lecture series covers the recent advances of planar optical measurement techniques with respect to their applicability to gas turbine component tests. During the last years much progress has been achieved in various known techniques, and new methods have been developed from which a significant increase of the experimental output of propulsion tests and therefore remarkable cost reduction can be expected. to bring this status into the knowledge of the propulsion specialists is the aim of this lecture series. Its theme is focused on laser measurement methods for the analysis of the internal flow and reaction processes in propulsion engines. It will address techniques for the measurement of flow velocity, flow density, pressure, temperature and species concentration. Only those methods are introduced which are far enough developed to be applicable to the rough test conditions of propulsion experiments. The course will inform the audience about the fundamentals of the advanced measurement techniques, as well as demonstrate their use in the context of practical applications. The material in this publication was collected from the research centers of the different NATO nations. It will transfer to the propulsion engineers in a condensed manner the information of the newest capabilities of modern test techniques thus providing the knowledge base for tomorrow's measurement instrumentation of propulsion test facilities. NATO's specific interest in sponsoring this event is based on the requirement for engines of extreme performance characteristics which cannot be realised without further improvements of both CFD and measurement technologies.

Author

Conferences; Flow Measurement; Flow Velocity; Gas Turbine Engines; Optical Measurement

19990102971 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Propulsion Technology, Cologne, Germany

Capabilities of Optical Point Measurement Techniques with Respect to Aero Engine Application

Schödl, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Planar Optical Measurement Methods for Gas Turbine Components; September 1999, pp. 1-1 - 1-15, In English; See also 19990102970; Original contains color illustrations; Copyright Waived; Avail: CASE: A03, Hardcopy: A02, Microfiche

Concerning the further development of gas turbine engines advances of the aero-thermodynamic design can be achieved most efficiently by co-operative efforts aimed at the improvement of both the numerical simulation methods and the experimental test and measurement techniques. Rapid development of numerical capability is accompanied with increasing demands on experimental data. In this context significant instrumentation research efforts are being conducted to develop the needed measurement technologies. In this paper an overview about the current capabilities of point measurement techniques as LDA, PDA, L2F, CARS under turbomachinery test conditions is presented. Three component laser velocimetry is treated to a great extend pointing out both examples of successful measurements with detailed flow information and in which way application related problems were solved. Examples of successful applications of CARS thermometry to jet engine combustors are also given together with an estimation of its application limits. The paper concludes with an evaluation of the power of point measurement techniques in comparison to planar techniques

Author

Laser Anemometers; Laser Doppler Velocimeters; Optical Measurement; Temperature Measurement; Gas Turbine Engines; Jet Engines; Procedures

19990102972 NASA Glenn Research Center, Cleveland, OH USA

Application of Digital Particle Imaging Velocimetry to Turbomachinery

Wernet, Mark P., NASA Glenn Research Center, USA; Planar Optical Measurement Methods for Gas Turbine Components; September 1999, pp. 2-1 - 2-33; In English; See also 19990102970; Original contains color illustrations; Copyright Waived; Avail: CASE: A03, Hardcopy: A02, Microfiche

Digital Particle Imaging Velocimetry (DPIV) is a powerful measurement technique, which can be used as an alternative or complementary approach to Laser Doppler Velocimetry (LDV) in a wide range of research applications. The instantaneous planar velocity measurements obtained with PIV make it an attractive technique for use in the study of the complex flow fields encountered in turbomachinery. Many of the same issues encountered in the application of LDV to rotating machinery apply in the application of PIV. Techniques for optical access, light sheet delivery, CCD camera technology and particulate seeding are discussed. Results from the successful application of the PIV technique to both the blade passage region of a transonic axial

compressor and the diffuser region of a high speed centrifugal compressor are presented. Both instantaneous and time-averaged flow fields were obtained. The 95% confidence intervals for the time-averaged velocity estimates were also determined. Results from the use of PIV to study surge in a centrifugal compressor are discussed. In addition, combined correlation/particle tracking results yielding super-resolution velocity measurements are presented.

Author

*Correlation Detection; Particle Image Velocimetry; Velocity Measurement; Turbomachinery; Transonic Compressors; Procedures*

19990102974 Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Inst. of Propulsion Technology, Cologne, Germany  
Planar Quantitative Scattering Techniques for the Analysis of Mixing Processes, Shock Wave Structures and Fluid Density

Schödl, R., Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Germany; Planar Optical Measurement Methods for Gas Turbine Components; September 1999, pp. 3-1 - 3-15; In English; See also 19990102970; Copyright Waived; Avail: CASI; A03, Hardcopy; A02, Microfiche

Quantitative Visualization Techniques (QVT) considered in this contribution are planar measurement techniques which make use of laser light sheet and CCD-camera and deliver quantitative information of flow properties. The elastic scattering of laser light either on seeding particles or molecules is used for the measurement. Three different methods are treated: The Quantitative Light Sheet (QLS) technique for mass-fraction measurement of mixing processes, The Tracer based Shock Visualization (TSV) for the measurement of shape and structure of compression shocks and UV-Rayleigh Scattering density measurements for flow Results of measurements in a model combustor, in a transonic compressor and in a turbine cascade are presented and discussed.

Author

*Procedures; Flow Characteristics; Density Measurement; Elastic Scattering*

19990104277 NASA Langley Research Center, Hampton, VA USA

Jet Nozzle Having Centerbody for Enhanced Exit Area Mixing

Seiner, John M., Inventor, NASA Langley Research Center, USA; Gilinsky, Mikhail M., Inventor, NASA Langley Research Center, USA; Jul. 20, 1999; In English; Provisional US-Patent-Appl-SN-016741, filed 2 May 1996  
Patent Info.: Filed 2 May 1997; NASA-Case-LAR-15518-1; US-Patent-5,924,632; US-Patent-Appl-SN-850572; US-Patent-Appl-SN-016741; No Copyright; Avail: US Patent and Trademark Office, Hardcopy

A nozzle arrangement includes a nozzle and a centerbody. The longitudinal axis of the centerbody is coaxially aligned with the nozzle. The centerbody has a free end portion shaped to create vortices in exhaust exiting the exit area. The vortices enhance mixing action in the exhaust and reduce exhaust noise while augmenting thrust.

Author

*Exhaust Nozzles; Nozzle Design; Coaxial Nozzles; Noise Reduction*

19990104350 Allison Engine Co., Indianapolis, IN USA

Aviation Turbine Engine Diagnostic System (ATEDS) for the OH-58D Helicopter *Final Report*

DeMott, Larry R.; Jul. 1999; 363p; In English

Contract(s)/Grant(s): DAAJ02-97-C-0014

Report No.(s): AD-A366338; EDR-18882; USAAMCOM-TR-99-D-22; No Copyright; Avail: CASI; A03, Microfiche; A16, Hardcopy

The US Army has documented the need for improved equipment and procedures to provide electronic troubleshooting/diagnostics of helicopter turbine engines. The Aviation Turbine has been initiated to address this need. A key element of the system development requires the creation of detailed, step-by-step, troubleshooting/diagnostic procedures and conversion of this data to electronic format compatible with the overall system. This report documents the activity accomplished by Rolls-Royce Allison in developing this data for application to the OH-58D Kiowa Warrior helicopter.

DTIC

*Turbine Engines; Diagnosis; Helicopter Engines; Systems Engineering*

19990105703 NASA Marshall Space Flight Center, Huntsville, AL USA

Overview of Current Turbine Aerodynamic Analysis and Testing at MSFC

Griffin, Lisa W., NASA Marshall Space Flight Center, USA; Hudson, Susan T., NASA Marshall Space Flight Center, USA; Zoladz, Thomas F., NASA Marshall Space Flight Center, USA; Sep. 13, 1999; 1p; In English; 10th; Thermal and Fluids Analysis, 13-17 Sep. 1999, Huntsville, AL, USA; No Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

An overview of the current turbine aerodynamic analysis and testing activities at NASA/Marshall Space Flight Center (MSFC) is presented. The presentation is divided into three areas. The first area is the three-dimensional (3D), unsteady Computational Fluid Dynamics (CFD) analysis of the Fastrac turbine. Results from a coupled nozzle, blade, and exit guide vane analysis and from an uncoupled nozzle and coupled blade and exit guide vane will be presented. Unsteady pressure distributions, frequencies, and exit profiles from each analysis will be compared and contrasted. The second area is the testing and analysis of the Space Shuttle Main Engine (SSME) High Pressure Fuel Turbopump (HPFTP) turbine with instrumented first stage blades. The SSME HPFTP turbine was tested in air at the MSFC Turbine Test Equipment (TTE). Pressure transducers were mounted on the first stage blades. Unsteady, 3D CFD analysis was performed for this geometry and flow conditions. A sampling of the results will be shown. The third area is a status of the Turbine Performance Optimization task. The objective of this task is to improve the efficiency of a turbine for potential use on a next generation launch vehicle. This task includes global optimization for the preliminary design, detailed optimization for blade shapes and spacing, and application of advanced CFD analysis. The final design will be tested in the MSFC TTE.

**Author**

*Turbines; Aerodynamic Characteristics; Performance Tests; Computational Fluid Dynamics; Three Dimensional Flow; Unsteady Flow; Dimensional Analysis; Design Analysis*

19990105814 National Aerospace Lab., Ramjet Propulsion Research Div., Tokyo, Japan

Mach 6 Testing of a Scramjet Engine Model

Kanda, T.; Saito, T.; Kudoh, K.; Komuro, T.; Ono, F.; Jul. 1998; 32p; In Japanese; Portions of this document are not fully legible  
Report No.(s): PB99-164956; NAL-TR-1364; Copyright: Avail: National Technical Information Service (NTIS), Hardcopy

Testing of a sub-scale scramjet research engine model was carried out in the Mach 6 Ramjet Engine Test Facility of the National Aerospace Laboratory, Kakuda Research Center. With attachment of a short strut on the top wall, intensive combustion with high combustion efficiency was attained, and the engine-produced thrust canceled the drag. The flame was held in the low-velocity region around the step, even after the ignitors had been turned off. When the fuel flow rate was small, there was a different combustion mode with weak combustion and little thrust. Tangential injection of fuel inhibited intensive combustion. NTIS

*Engine Tests; Supersonic Combustion Ramjet Engines*

## 08 AIRCRAFT STABILITY AND CONTROL

*Includes aircraft handling qualities; piloting; flight controls; and autopilots.*

19990090018 George Washington Univ., Joint Inst. for Advancement of Flight Sciences, Hampton, VA USA

Modeling of Longitudinal Unsteady Aerodynamics of a Wing-Tail Combination

Klein, Vladislav, NASA Langley Research Center, USA; September 1999; 29p; In English

Contract(s)/Grants: NCC1-29; RTOP 522-33-11-05

Report No.(s): NASA/CR-1999-209547; NAS 1.26:209547; No Copyright: Avail: CASI, A03, Hardcopy; A01, Microfiche

Aerodynamic equations for the longitudinal motion of an aircraft with a horizontal tail were developed. In this development emphasis was given on obtaining model structure suitable for model identification from experimental data. The resulting aerodynamic models included unsteady effects in the form of linear indicial functions. These functions represented responses in the lift on the wing and tail alone, and interference between those two lifting surfaces. The effect of the wing on the tail was formulated for two different expressions concerning the downwash angle at the tail. The first expression used the Cowley-Glauert approximation known as "lag-in-downwash" the second took into account growth of the wing circulation and delay in the development of the lift on the tail. Both approaches were demonstrated in two examples using the geometry of a fighter aircraft and a large transport. It was shown that the differences in the two downwash formulations would increase for an aircraft with long tail arm performing low-speed, rapid maneuvers.

**Author**

*Unsteady Aerodynamics; Longitudinal Stability; Aerodynamic Stability; Aircraft Stability*

19990091943 Cranfield Univ., Flight Test and Dynamics Group, Bedford, UK

A generic control anticipation parameter for aircraft handling qualities evaluation

Gautrey, J. E., Cranfield Univ., UK; Cook, M. V., Cranfield Univ., UK; The Aeronautical Journal; Mar. 1998; Volume 102, No. 1013, pp. 151-160; In English; See also 19990091939; Copyright: Avail: Issuing Activity, Hardcopy

The established control anticipation parameter longitudinal handling qualities criterion is based on the assumption that the short term dynamic response of the aeroplane is classical, or second-order-like. Modern fly-by-wire aircraft often have longitudinal short term dynamics which are not second-order-like and to which it is difficult to apply the criterion. This paper presents a proposed generic control anticipation parameter which is a modified version of the control anticipation parameter and which may be applicable to both unaugmented and augmented aircraft of all types. The appropriateness of the modified criterion was illustrated by designing a number of command and stability augmentation control laws, constrained to meet the criterion, for application to a medium weight fly-by-wire civil transport aircraft. The handling characteristics conferred by the control laws were assessed in a series of flight simulator trials, the results of which are briefly presented.

**Author**

*Command and Control; Flight Characteristics; Fly by Wire Control; Dynamic Response; Aircraft Control; Control Stability; Longitudinal Control; Controllability*

19990097427 Old Dominion Univ., Aerospace Engineering Dept., Norfolk, VA USA

Flow Control and Modification for Alleviating Twin-Tail Buffet

Kandil, Osama A., Old Dominion Univ., USA; Yang, Zhi, Old Dominion Univ., USA; Sheta, Essam F., Old Dominion Univ., USA; [1999]; 14p; In English; 37th Aerospace Sciences, 11-14 Jan. 1999, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Contract(s)/Grant(s): NAG1-648

Report No.(s): AIAA Paper 99-0138; Copyright: Avail: Issuing Activity, Hardcopy

Active flow control for twin-tail buffet alleviation is investigated. Flow suction along the vortex cores (FSVC) of the leading edges of the delta wing is used in order to delay the vortex breakdown flow upstream of the twin tail and to modify the vortex core path. A parametric study of the effects of the spanwise position and axial orientation of the suction tubes on the twin-tail buffet response is carried out. The computational model consists of a sharp-edged delta wing of aspect ratio one and swept-back flexible twin tail with taper ratio of 0.23. This complex multidisciplinary problem is solved sequentially using three sets of equations for the fluid flow, aeroelastic response and grid deformation, using a dynamic multiblock grid structure. The computational model is pitched at 30 deg angle of attack. The freestream Mach number and Reynolds number are 0.3 and 1.25 million, respectively. The model is investigated for the inboard position of the twin tails, which corresponds to a separation distance between the twin tails of 33% of the wing span. Comparison of the time history and power spectral density responses of the tails for various FSVC controls are presented and discussed.

**Author**

*Buffeting; Flow Distribution; Free Flow; Turbulent Flow; Reynolds Number; Vortex Breakdown; Multiblock Grids; Vortices; Computational Fluid Dynamics*

19990097512 Kyushu Univ., Faculty of Engineering, Fukuoka, Japan

Active Flutter Suppression Experiment: Estimation of the Flutter Speed Using Exact Transcendental Functions

Hokamoto, Shinji, Kyushu Univ., Japan; Nagasato, Shohei, Kyushu Univ., Japan; Goto, Norihiro, Kyushu Univ., Japan; Technology Reports of Kyushu University; Nov. 1997; ISSN 0023-2718; Volume 70, No. 6, pp. 631-635; In Japanese; No Copyright: Avail: Issuing Activity, Hardcopy, Microfiche

This paper deals with the flutter phenomenon of a thin wing with one degree of freedom. Two procedures to estimate the flutter speed are compared: one is to approximate the general Theodorsen function by a rational function; the other is to use the exact transcendental function. For the former procedure, the numerical result shows that the estimated flutter speed has a tendency to be higher than the one by the latter procedure as the damping term becomes larger. On the other hand, from the experimental results, it is shown that the proposed estimation procedure based on exact transcendental functions shows good estimates even when active flutter control is applied.

**Author**

*Active Control; Flutter; Thin Wings; Transcendental Functions; Vibration Damping; Theodorsen Transformation*

19990099322 Georgia Inst. of Tech., School of Aerospace Engineering, Atlanta, GA USA

Robust Fixed-Architecture Linear and Nonlinear Control Final Report, 15 Apr. 1996 - 15 Apr. 1999

Haddad, Wassim M.; Jul. 10, 1999; 48p; In English

Contract(s)/Grant(s): F49620-96-1-0125

Report No.(s): AD-A366043; AFRL-SR-BL-TR-99-0179; No Copyright: Avail: CASI; A03, Hardcopy; A01, Microfiche

Controls research under this program has concentrated on the development of linear and nonlinear robust fixed structure control for aerospace systems. Specifically, a unified robust nonlinear design framework was developed that provides significant

extensions of state of the art recursive backstepping nonlinear control methods to include notions of optimality, robustness, disturbance rejection, actuator constraints, and adaptation. Furthermore, a general nonlinear control design framework predicated on a hierarchical switching controller architecture was developed. The proposed framework provides a rigorous alternative to designing gain scheduled feedback controllers that guarantee global closed loop system stability for nonlinear systems. The aforementioned nonlinear control design frameworks were applied to the control of thermoacoustic combustion instabilities and compressor aerodynamic instabilities involving rotating stall and surge in aeroengines.

DTIC

*Flight Control; Adaptive Control; Aircraft Engines; Control Theory; Controllers; Feedback Control; Nonlinear Systems; Robustness (Mathematics)*

19990100653 George Washington Univ., Joint Inst. for Advancement of Flight Sciences, Hampton, VA USA

Modeling of Longitudinal Unsteady Aerodynamics of a Wing-Tail Combination

Klein, Vladislav, George Washington Univ., USA; September 1999; 32p; In English

Contract(s)/Grant(s): NCC1-29; RTOP 522-33-11-05

Report No.(s): NASA/CR-1999-209547; NAS 1.26:209547; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

Aerodynamic equations for the longitudinal motion of an aircraft with a horizontal tail were developed. In this development emphasis was given on obtaining model structure suitable for model identification from experimental data. The resulting aerodynamic models included unsteady effects in the form of linear indicial functions. These functions represented responses in the lift on the wing and tail alone, and interference between those two lifting surfaces. The effect of the wing on the tail was formulated for two different expressions concerning the downwash angle at the tail. The first expression used the Cowley-Glauert approximation known as "lag-in-downwash," the second took into account growth of the wing circulation and delay in the development of the lift on the tail. Both approaches were demonstrated in two examples using the geometry of a fighter aircraft and a large transport. It was shown that the differences in the two downwash formulations would increase for an aircraft with long tail arm performing low-speed, rapid maneuvers.

Author

*Unsteady Aerodynamics; Aerodynamic Characteristics; Aerodynamic Stability; Longitudinal Stability; Lift; Pitching Moments; Wind Tunnel Tests*

19990103049 McGill Univ., Dept. of Electrical and Computer Engineering, Montreal, Quebec Canada

Cellular Decomposition Based Hybrid-Hierarchical Control Systems with Applications to Flight Management Systems

Final Report

Caines, P. E., McGill Univ., Canada; [1999]; 7p; In English

Contract(s)/Grant(s): NAG2-1040; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

The work in this research project has been focused on the construction of a hierarchical hybrid control theory which is applicable to flight management systems. The motivation and underlying philosophical position for this work has been that the scale, inherent complexity and the large number of agents (aircraft) involved in an air traffic system imply that a hierarchical modelling and control methodology is required for its management and real time control. In the current work the complex discrete or continuous state space of a system with a small number of agents is aggregated in such a way that discrete (finite state machine or supervisory automaton) controlled dynamics are abstracted from the system's behaviour. High level control may then be either directly applied at this abstracted level, or, if this is in itself of significant complexity, further layers of abstractions may be created to produce a system with an acceptable degree of complexity at each level. by the nature of this construction, high level commands are necessarily realizable at lower levels in the system.

Author

*Research; Control Theory; Air Traffic Control*

19990103171 NASA Marshall Space Flight Center, Huntsville, AL USA

X-33 Attitude Control Using the XRS-2200 Linear Aerospike Engine

Hall, Charles E., NASA Marshall Space Flight Center, USA; Panossian, Hagop V., Boeing Co., USA; 1999; 1p; In English; 35th; Joint Propulsion, 20-24 Jun. 1999, Los Angeles, CA, USA; Sponsored by American Institute of Aeronautics and Astronautics; Copyright: Avail: Issuing Activity, Hardcopy; Abstract Only

The Vehicle Control Systems Team at Marshall Space Flight Center, Structures and Dynamics Laboratory, Guidance and Control Systems Division is designing, under a cooperative agreement with Lockheed Martin Skunkworks, the Ascent, Transition, and Entry flight attitude control systems for the X-33 experimental vehicle. Test flights, while suborbital, will achieve sufficient altitudes and Mach numbers to test Single Stage to Orbit, Reusable Launch Vehicle technologies. Ascent flight control

phase, the focus of this paper, begins at liftoff and ends at linear aerospike main engine cutoff (MECO). The X-33 attitude control system design is confronted by a myriad of design challenges: a short design cycle, the X-33 incremental test philosophy, the concurrent design philosophy chosen for the X-33 program, and the fact that the attitude control system design is, as usual, closely linked to many other subsystems and must deal with constraints and requirements from these subsystems. Additionally, however, and of special interest, the use of the linear aerospike engine is a departure from the gimbaled engines traditionally used for thrust vector control (TVC) in launch vehicles and poses certain design challenges. This paper discusses the unique problem of designing the X-33 attitude control system with the linear aerospike engine, requirements development, modeling and analyses that verify the design.

**Author**

*X-33 Reusable Launch Vehicle; Aerospike Engines; Laboratory Equipment; Flight Control; Engine Design; Control Systems Design*

19990105691 CSA Engineering, Inc., Palo Alto, CA USA

An Experimental Investigation of Tangential Blowing to Reduce Buffet Response of the Vertical Tails of an F-15 Wind Tunnel Model, Volume I, Tests Results, Discussion and Correlation *Final Report, 1 Jun. 1996 - 31 Dec. 1998*

Ferman, Mrty A.; Turner, Elijah W.; Jan. 1999; 241p; In English

Contract(s)/Grant(s): F33615-94-C-3200; AF Proj. 2404

Report No.(s): AD-A367319; AFRL-VA-WP-TR-1999-3018; No Copyright; Avail: CASI; A03, Microfiche; A11, Hardcopy

Tangential blowing was investigated as a means to reduce buffeting pressures and response on the tails of a 4.7% scale model of the F-15 Fighter Aircraft in the Subsonic Aerodynamic Research Laboratory (SARL) wind tunnel. Buffeting pressures, structural strains, and structural acceleration were measured and recorded for a range of angles of attack and angles of side slip, and for blowing at three locations on the model, both individually, in combinations, and without blowing. The test were conducted for two wind tunnel dynamic pressures. One vertical tail was rigid to permit buffet excitation pressures to be measured, and the other was flexible to permit buffet response pressures and structural response to be measured. Unsteady pressure data, strains and accelerations were reduced to PSD and RMS forms. This report contains a general description of the model, the test program, samples of the reduced data, an in depth analysis of the data, and conclusions with respect to the effectiveness of blowing to reduce buffeting of vertical tails.

**DTIC**

*Tangential Blowing; Buffeting; Tail Assemblies; Wind Tunnel Tests; Vertical Orientation; Wind Tunnel Models*

19990105718 California Univ., Coll. of Engineering, Santa Barbara, CA USA

Robust Nonlinear Control of Tailless Aircraft *Final Report, 1 Dec. 1997 - 30 Nov. 1998*

Teel, Andrew R.; Feb. 1999; 19p; In English

Contract(s)/Grant(s): F49620-98-1-0087

Report No.(s): AD-A367415; AFRL-SR-BL-TR-99-0204; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

The objective of this research was to develop tools leading to effective control strategies for tailless fighter aircraft. Emphasis was placed on the development of control algorithms that yield robust performance in the presence of actuator magnitude and rate limits and that account for the interaction of a pilot with the airframe and control system. The results of this research are documented in the 22 papers that are listed in this report. These papers present the development of numerous new analysis tools for nonlinear control systems with an emphasis on disturbance attenuation and sampled data control. These algorithms were applied to the manual flight control problem for open loop unstable fighter aircraft.

**DTIC**

*Manual Control; Tailless Aircraft; Aerodynamic Stability; Flight Control*

**09**  
**RESEARCH AND SUPPORT FACILITIES (AIR)**

*Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.*

19990088116 Naval Postgraduate School, Monterey, CA USA

Economic Aspects of Airport Security Measures

Sanios, Alvaro K.; Jun. 1999; 82p; In English

Report No.(s): AD-A366334; No Copyright; Avail: CASI; A05, Hardcopy; A01, Microfiche

Airport security measures use very expensive equipment, and may keep passengers in line for several minutes. The time passengers spend in those lines can add up, and must be understood as time opportunity cost. In the 1970s, several airport security measures were adopted to help stop aircraft hijackings. In 1978, William M. Landes wrote the paper "An Economic Study of the U.S. Aircraft Hijacking, 1961-1976", in which he analyzed the expenditures associated with airport security measures. He concluded that the costs of the adopted measures were very high. While Landes concentrated on the monetary costs of airport security, this thesis concentrates on the estimating the opportunity costs of airport security measures for passengers -- their losses in terms of their time value. This thesis estimates that the hijacking-preventing impact of airport screening measures is insignificant, but the opportunity costs these measures impose on airline passengers are significant and greatly exceed the benefits produced.

DTIC

*Airport Security; Economics; Estimates; Costs*

19990089317 Kyushu Univ., Graduate School of Engineering, Fukuoka, Japan

Subsonic Wind Tunnel Facility for PIV and Blade Flutter Experiments

Toshimitsu, Kazu, Kyushu Univ., Japan; Ogawa, Tetsuaki, Kyushu Univ., Japan; Murakami, Satoko, Kyushu Univ., Japan; Orino, Minori, Kyushu Univ., Japan; Namba, Masanobu, Kyushu Univ., Japan; Technology Reports of Kyushu University; May 1999; Volume 72, No. 3, pp. 215-222; In Japanese; See also 19990089315; No Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

The paper presents an overview, components and basic performance of a subsonic wind tunnel facility for particle image velocimetry (PIV) measurement and three-dimensional blade flutter experiment. The PIV system comprises a double-pulsed ND:YAG laser, a CCD camera and a seeding apparatus which consists of a fog generator, an aerosol seeder and a cyclone. The fog generator is useful for a qualitative visualization in low-speed flows. The aerosol seeder can be utilized as a continuously agitated fluidized-bed solid particle generator for a quantitative PIV visualization in high-speed flows. The cyclone is particularly successful in removing the large particle agglomerates typically produced by the solid particle resuspension process that takes place in the aerosol generator. Using the PIV system, customized image acquisition is used to quickly process the data, and the two-dimensional velocity field is rapidly provided. A uniform flow velocity of 75.9 m/s is presented as the example of the PIV measurement. The flutter frequency and the critical velocity are estimated 130 Hz and 114 m/s respectively from the flutter experiment of the three-dimensional flat plate blade in subsonic flows.

Author

*Particle Image Velocimetry; Flutter; Subsonic Wind Tunnels*

19990091944 China Junior Coll. of Marine Technology, Dept. of Telecommunication Engineering, Taipei, Taiwan, Province of China

A robust controller design for supersonic intermittent blowdown-type wind tunnels

Hwang, D.-s., China Junior Coll. of Marine Technology, Taiwan, Province of China; Hsu, P.-L., National Chiao Tung Univ., Taiwan, Province of China; The Aeronautical Journal; Mar. 1998; Volume 102, No. 1013, pp. 161-169; In English; See also 19990091939; Copyright; Avail: Issuing Activity, Hardcopy

Effective operation of a large-scale supersonic intermittent blow down windtunnel system requires suitable control of the air control valve to establish the desired pressure profile in the settling chamber and generate a corresponding supersonic air flow. In this paper, we establish a lumped parameter nonlinear time-varying mathematical model for blowdown-type wind tunnels, based on the thermal-fluid mechanical balance principle. We apply the LQG/LTR procedure to achieve a robust controller design that diminishes the effects of unavoidable uncertainties and time-varying characteristics and obtains the desired experimental environment in the system. Simulation results show that this Linear Quadratic Gaussian/Loop Transfer Recovery (LQG/LTR) based controller, with a carefully selected loop shape combining both anti-integrator windup and the time-delay compensation schemes, achieves satisfactory control performance for the entire wind tunnel testing procedure.

Author

*Supersonic Flow; Linear Quadratic Gaussian Control; Controllers; Air Flow; Supersonic Wind Tunnels; Wind Tunnel Models; Loop Transfer Recovery; Mathematical Models*

19990098427 Idaho National Engineering Lab., Idaho Falls, ID USA

Conceptual Design Report for the Extreme Ecosystems Test Chambers

C. Barnes., Idaho National Engineering Lab., USA; J. Beller., Idaho National Engineering Lab., USA; K. Caldwell., Idaho National Engineering Lab., USA; K. Croft., Idaho National Engineering Lab., USA; R. Cherry., Idaho National Engineering Lab., USA; Dec. 01, 1998; 125p; In English

Report No.(s): DE00-005494; INEEL/EXT-98-00938; No Copyright; Avail: Department of Energy Information Bridge, Hardcopy

This conceptual design supports the creation of Extreme Ecosystems Test Chambers, which will replicate deep subsurface and subocean environments characterized by high pressure (2,000 psi) and subfreezing to high temperature (-4 to 300 degrees F) with differing chemical and saturation conditions. The design provides a system to support research and development that includes heat transfer, phase change issues in porous media, microbiology in extreme environments, and carbon sequestration and extraction. The initial system design is based on the research needs to support the commercial production of methane hydrates from subsurface sediments. The design provides for three pressure vessels: a Down Hole Test Vessel, a Vertical Multi-phase Test Vessel, and a Horizontal Multi-phase Test Vessel.

NTIS

*Test Chambers; Ecosystems; Design Analysis; Systems Engineering*

19990099128 Institute for Human Factors TNO, Soesterberg, Netherlands

Performance Tests of the Upgrade of the YPR 765 Driving Simulator *Interim Report Prestatietests van de verbetering van de YPR 765 rijimulator*

Padmos, P., Institute for Human Factors TNO, Netherlands; May 07, 1999; 15p; In English

Contract(s)/Grant(s): A96/KL/345; TNO Proj. 730.3

Report No.(s): TD99-0041; TM-99-A035; Copyright; Avail: Issuing Activity, Hardcopy

On the YPR 765 driving simulator, in use for training by the Royal Netherlands Army, an upgrade took place recently. This upgrade consisted of the following: (1) installing a Bird's Eye View system (BEV), enabling the instructor to exactly monitor the vehicle's position in its environment; (2) installing a Performance Measurement and Feedback system (IPMF), which automatically measures and reports the driving performance of a trainee, and compares this with performance of other trainees; and (3) improving the SPRITE system for vehicle-terrain interaction. Performance tests of these systems were conducted, based on system specifications designed by the TNO Human Factors Research Institute. These tests revealed many items which were not according to the specifications, or for which improvement was wanted. Presently, most of these errors have been repaired by the manufacturer. A few other minor errors or improvements wanted, which are not critical for the system's performance, were neglected. Several points of attention remain, which are summarized in Chapter 3 "Conclusions and recommendations".

Author

*Performance Tests; Training Simulators; Human Factors Engineering; Feedback*

19990099129 Institute for Human Factors TNO, Soesterberg, Netherlands

Possibilities for Standardization and Integration of the Simulators of the Air Defence Training Centre *Final Report De mogelijkheden tot standaardisering en integratie van de trainers van de School LuchtdoelArtillerie*

Boot, E. W., Institute for Human Factors TNO, Netherlands; vanRooij, J. C. G. M., Institute for Human Factors TNO, Netherlands; Apr. 29, 1999; 54p; In Dutch

Contract(s)/Grant(s): A97/KL/354; TNO Proj. 730.1

Report No.(s): TD99-0035; TM-99-A030; Copyright; Avail: Issuing Activity, Hardcopy

At the training centre for air defence, soldiers are trained for different air defence functions. Within the different training programs a variety of training simulators is being used. In the near future a number of the simulators that are presently being used will be replaced or upgraded. There are also plans for the procurement of new air defence systems which also imply procurement of training simulators. In the context of these upgrades and extensions questions have arisen with respect to the possibilities for more efficient management; particularly with respect to the standardization and exchange of (parts of) simulators and the exchange of personnel. In answering these questions the recently developed MASTER methodology for the specification of training simulators has been used as a guideline. It is concluded that although, globally speaking, the different simulators appear to share a large functional overlap, this overlap is more apparent than real. However, especially with respect to target models, target trajectories and databases (in other words the simulation of the battlefield) there are good possibilities for re-use/exchange. As far as other simulator components are concerned these possibilities are more limited. These limitations are mainly the result of the fact that weapon systems are procured and deployed on the basis of their complementarity and not on the basis of their overlap. This means that tasks will be different and, consequently, also the training objectives and the design of the training programmes. Due to these differences, the possibilities for exchanging instructional developers and instructors are limited. Although the possibilities for improving management are more limited than originally expected, several recommendations could be proposed for improving the procurement and management process.

Author

*Standardization; Air Defense; Training Simulators; Education*

19990099130 Institute for Human Factors TNO, Soesterberg, Netherlands

Specification and Evaluation of the Functional Requirements of a UAV Crew Trainer *Final Report Specificatie en evaluatie van de functionele eisen van een UAV Trainer*

Helsdingen, A. S., Institute for Human Factors TNO, Netherlands; Aug. 12, 1999; 52p; In English; Original contains color illustrations

Contract(s)/Grant(s): A96/CO/363; TNO Proj. 43

Report No.(s): TD99-0332; TM-99-A055; Copyright; Avail: Issuing Activity, Hardcopy

To investigate the possibilities for application of low-cost simulators within military training courses, the research project called ELSTAR (European Low-cost Simulation technology for the ARmed forces) is carried out under the contract of the Ministries of Defence of the five participating countries of Research Technology Project (RTP) 11.8, viz. Belgium, France, Germany, Greece, and The Netherlands. This project consists of 5 work packages. In the current work package 3 of the ELSTAR project, an elaborate investigation of the task- and training requirements of the selected training areas, must render more detailed descriptions of four selected training systems. The current report includes a task- and training analysis of a Unmanned Aerial Vehicle (UAV) crew, which formed the basis for the functional requirements of a UAV crew trainer. In order to determine low-cost solutions for this trainer, the cost driving requirements of the system were identified. The effects of degrading these requirements on the training value of the UAV crew trainer were evaluated in a experimental study. The results of the task and training analyses show that visual information is the most important source of information for the UAV crew to perform its tasks; therefore, the focus of the functional specifications is on the image system, with its image generator, display system, and visual database. In the development of a UAV simulator, it seems that the visual database is the major factor in the costs. This database needs to be large and very detailed, which causes the development to be time-consuming and expensive. In the evaluation study two degraded database configurations were tested: both configurations involve the definition of a high detail target area within the database, while the Surrounding area is either left out or displayed with a lower level of detail. The results show that the UAV experts evaluated both simulator configurations as having a high training value. Nevertheless, their additional remarks show that they see room for improvement. This evaluation experiment can be seen as a first attempt to define the value of specific configuration of subsystems of the simulator for training. In a later stage of this project, training value will be determined by objective measurements against alternative training methods.

Author

*Evaluation, Research and Development; Training Devices; Training Simulators; Education; Functional Design Specifications; Display Devices*

19990099362 Institut de Recherche des Transports, Arcueil, France

Smart Hubs: Integration Places

Bollo, Daniel, Institut de Recherche des Transports, France; Frybourg, Michel, Ecole Nouvelle d'Organisation Economique et Sociale, France; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 20p; In English; Copyright Waived; Avail: CASI, A03, Hardcopy; A03, Microfiche

The European Union focuses on horizontal integration, including the concepts of interconnection, interoperability and intermodality around which the common policy of transport is articulated. The clue put forward by the authors is the concept of vertical integration, on the basis of the banal remark that freight transport and the logistics sector are services activities and not an end in itself. In the current economy a competitive advantage provided by services often is linked with an value added service. The value added service is added to the basic service provision and precisely makes the difference and thus the benefit. We will present an analysis derived from the OSI model that splits concurrent activities in layers. Finally we assess the role of nodes in integrated transport services.

Author

*Cargo; Logistics; Policies; Civil Aviation*

19990099368 Regional Inst. for Economic Planning of Tuscany, Florence, Italy

City Airports and Sustainable Urban Development: The Case Study of Florence

Lorenzini, Stefania, Regional Inst. for Economic Planning of Tuscany, Italy; Maltinti, Giovanni, Regional Inst. for Economic Planning of Tuscany, Italy; Benvenuti, Stefano Casini, Regional Inst. for Economic Planning of Tuscany, Italy; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 22p; In English Report No.(s): Paper-667; Copyright Waived; Avail: CASI, A03, Hardcopy; A03, Microfiche

The role of infrastructure in the regional development process has been studied for a long time without specifying the direction of the causal relationship. This seems to be particularly true as far as the airports are concerned, which are often considered as strategical determinants of regional growth but also as a factor induced-in other contexts- by the development process itself. In

the first stages of development, it can be supposed a weak demand as far as air transport is concerned, in this scenario the decision of building a new airport -for instance in the capitol city of a country- might be considered as a supply-induced policy measure. In the following phases of growth, the demand for an adequate endowment of transport infrastructures becomes the prevailing factor in the decisions of carrying out investments in this field. In this framework, city-airports may be seen as "second generation" products if compared with the traditional airports; they meet, in fact, a more restricted and qualified part of mobility demand and are components of a more general "city marketing policy" induced by the need of the cities to be active in urban competition. The city airport of Florence -which showed in few years an important growth of traffic-constitutes the field of empirical analysis of the paper. After a short presentation of the present phase of Florence area development, as well as of the city-airports' case, the present and the future of Florence airport is described; in this part specific emphasis has been devoted to the 2010 demand's forecast by means of a gravity modal-split and econometric model. The second part of the paper analyses the effects of air traffic from the point of view of their typological nature (temporary, permanent, short and long term) taking into account, with a theoretical approach, the unavoidable trade-off between economic benefits and environmental effects.

Derived from text

*Airports; Air Traffic; Competition; Economics; Environment Effects*

19990099375 Technische Hogeschool, Faculty of Architecture, Delft, Netherlands

What Airport for the Future? Value Added, Durability and Cooperation

Drewe, Paul, Technische Hogeschool, Netherlands; Janssen, Ben, NEA Transport Research and Training, Netherlands; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 22p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The stage for discussing both the future of air transport and airports is usually set by a simplistic model of extrapolated growth of volumes (number of passengers as well as tons of freight). According to IATA passenger transport, for example, is expected to grow till 2015 world-wide at an average annual growth rate of approximately 5%. Individual airports may grow faster or slower. A simple extrapolation of their present growth would imply a fallacy of disaggregation as it does not take into account the competitive positioning of airports. If air transport is measured in terms of number of flights (transporting either passengers or freight) between origins and destinations, a simplistic approach to airport performance - counting only the number of passengers or tons of freight per airport - causes "double counting". Or even "quadruple counting" in the case of transit. The latter can be an important phenomenon as in the case of Schiphol with the transit shares of almost 50% and 60 to 70% in respectively passenger transport and freight transport. An origin destination matrix of passenger and freight flights including transit and containing information on respectively passenger- and ton-kilometers, provides a more accurate picture of air transport. It is important to gain insight into complete chains extending, ideally, to transport to and from airports. The problem is similar to the modeling of European freight transport. Especially congestion, say within the European Union, requires insight into interconnections at a higher level of aggregation than that of individual airports. Extrapolated growth of volumes is just one side of simplicity, the other side being the assumption of simple relationships between on the one hand, growth and the benefits and costs of air transport, on the other. Economic-benefit and social-cost arguments are more important in discussing the airport for the future than arguments related to either social benefits or economic costs.

Derived from text

*Durability; Cooperation; Airports; Extrapolation; Costs; Air Transportation*

19990099376 Al-Isra Univ., Civil Engineering Dept., Amman, Jordan

Estimating the Bias Resulting From the Use of Conventional Mode Choice Models

Abdelwahab, Walid, Al-Isra Univ., Jordan; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 14p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

With the advent of new major policy issues concerning intercity freight and passenger transportation, such as intermodal competition, deregulation, introduction of new modes and/or technologies, researchers have been increasingly dissatisfied with the application and performance of conventional mode choice models. Perhaps the most critical drawback in the application of these modes in the area of intercity freight transportation has been the inability of modeling decisions in a simultaneous rather than sequential matter. It is widely accepted that decision-makers, for example shippers, make their choices of mode, shipment size, frequency, and supply market simultaneously, not in sequence. Therefore, models that deal with only one of these choices, for example, the choice of mode, re-present only one part of the complete model. These models are suspected to produce inaccurate or "biased" results. Consequently, a number of researchers have developed alternative models to overcome this weakness. This paper provides quantitative evidence on the amount and significance of this "bias," by comparing a biased and a biased-free version of the same mode choice model calibrated from the same data set. The biased model is represented by a conventional probit model

choice model, whereas the bias-free model is represented by a simultaneous discrete/continuous model for the joint choice of mode and shipment size. The paper will mainly focus on the effects of simultaneity on the values and significance of the parameter estimates of conventional mode choice models, and on the magnitude of the own and cross elasticities of mode choice probabilities with respect to freight charges. The latter effects should provide all insight into the amount of bias in the degree of intermodal competition estimated in studies employing conventional mode choice models.

**Author**

*Competition; Estimates; Estimating; Mathematical Models; Passengers; Transportation*

**19990099399 HNTB Architects Engineering Planners, Fort Worth, TX USA**

Austin Bergstrom Airport Traffic Control Tower Establishment of a Major Activity Level Tower

Pillar, Roxanne L., HNTB Architects Engineering Planners, USA; Eisenrich, Brian, Southwest Carlson Associates, USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 15p; In English; See also 19990099396

Report No.(s): Paper-991-Rev; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Robert Mueller Airport has served the City of Austin, Texas, USA, since the 1930's. The surrounding area is completely developed, leaving the City unable to purchase land needed to expand runway capacity for long-term aviation demand. Voter referendums November 3, 1987 and May 1, 1993 confirmed the decision to develop a new commercial airport. Numerous studies identified the active Bergstrom Air Force Base as the preferred site. Options of joint military-civilian use of the Air Force Base were explored but no agreement could be reached. In July 1991, a USA Congressional commission formally recommended that the base be closed. On August 1, 1991, the Austin City Council passed a resolution formally designating Bergstrom as the preferred site for a new commercial airport. Located 7 miles southeast of the Austin central business district but within the city limits, the site is surrounded by predominantly undeveloped land. This paper covers the process utilized to convert a military facility to a commercial airport. The control tower project had to be submitted on fiscal year planning budgets and assigned a Congressional budget line item number. The budget line item number is used for the annual budget submittal to the USA (U.S.) Congress. Projects are prioritized and funded as monies are available. A project might go through the annual budget process as many as five times before being discarded or funded. Documentation of the problems and justification for the proposed action had to be submitted to Washington, D.C. and prioritized with other projects from across the USA of America. The City of Austin, Texas, made a commitment to provide portions of the funding to balance the federal government investment. After the project successfully maneuvered this process, project authorization was given by Congress and monies assigned to the project. The Federal Aviation Administration's (FAA) Southwest Regional Office staff was given the assignment to proceed. The FAA Airport Development Office, Airports Division provided grant funding to the City of Austin for portions of the sponsor improvements. The Airway Facilities Division managed the airport facility projects built by the FAA, including the Airport Traffic Control Tower. Austin Bergstrom International Airport is the only new major activity airport under construction in the USA at this time.

**Author**

*Air Traffic Control; Airport Towers; Budgeting; Construction*

**19990099400 Civil Aviation Authority, Netherlands**

A Study to Optimize the Environmental Capacity of Amsterdam Airport Schiphol

deWit, Jaap, Civil Aviation Authority, Netherlands; Veldhuis, Jan, Civil Aviation Authority, Netherlands; Uittenboogaart, Peter, Civil Aviation Authority, Netherlands; Wei-Yun, Thalia, Civil Aviation Authority, Netherlands; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 9p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The last five years Amsterdam Airport has experienced an extremely high growth. However this growth can be attributed only partly to the growth of the airline market itself. The economic growth of the Netherlands and the Western European region has been moderate in the period 1992-1995. Only 1996 and 1997 have shown some economic recovery, at least in the Netherlands. A factor that certainly has contributed to airline market growth concerns the air fares, which have dropped considerably, especially through the introduction of new promotional fares. But even taking the fares into consideration, the contribution of market growth to Schiphol's growth is moderate. The main factor has been the market share of KLM and its partners. A number of factors can be mentioned in this context. During the first half of the 90's KLM has extended the co-operation with Northwest Airlines, mainly by code sharing on the North Atlantic route, and by offering through connections in the USA by the Northwest-network, and in Europe by the KLM-network. An important year was 1992, when the Netherlands - as the first European state - signed an Open Skies Agreement with the USA. In this agreement an anti-trust immunity for KLM/Northwest was included which made it possible to closely integrate both airline networks. This stimulated traffic at Schiphol further. Also during that period KLM started to build up a new wave system at Schiphol, by concentrating European arrivals and departures (in addition to the European and

intercontinental) in such a way that connectivity via Schiphol improved considerably, which mainly boosted the connecting traffic via Schiphol.

Derived from text

*Research; Optimization; Environmental Quality; Airports; Netherlands; Airline Operations*

19990099401 New South Wales Univ., School of Civil and Environmental Engineering, Sydney, Australia

Airport Performance in Stakeholder Involvement and Communication Strategies: A Comparison of Major Australian and North American Air Carrier and General Aviation Airports

Black, John, New South Wales Univ., Australia: The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 20p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Communication strategies to engage key stakeholders and communities is a neglected aspect on airport management performance. Benchmarking studies have been conducted at selected airports in Australia and the U.S.A. where facilities are being expanded to accommodate traffic growth. Major issues are aircraft noise, air quality and ground access. The paper reports on environmental management studies, in general, and corporate communications strategies, in particular. Examples of best practice are drawn from U.S. airports. Although environmental management and community participation are established for the Federal Airports Corporation, the recent privatisation of its 22 airports (except for those in the Sydney basin) means that new challenges are faced by airport managers. Interviews conducted as part of the benchmarking study and research into public relations leads to recommendations for corporate change that include more symmetrical communications strategies.

Author

*Airports; Environment Management; Organizations; Air Quality; Aircraft Noise*

19990099402 Tel-Aviv Univ., Ramat-Aviv, Dept. of Geography, Tel-Aviv, Israel

Airport Planning and Location

Goodovitch, Tomer, Tel-Aviv Univ., Ramat-Aviv, Israel: The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 20p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Geographers have long been attempting to discover the spatial regularities of economic development. A critical factor in this process has been the improvement of spatial interaction through the development of transportation systems. From its beginning metropolitan transportation development has been a continuous process of spatial diffusion but also a sporadic process influenced by many specific forces: economic, social and political. Whereas the historical development of maritime and land transport has been well documented in numerous studies, the evolution of air transport has more often been treated separately or on the basis of interregional relationships. From a historical perspective most large metropolitan concentrations owe their existence to water and rail transportation. Air transport has now replaced maritime transport and railways as the basis for trade, technological transfer and economic growth. For example, a city would likely be built next to a natural harbor. As the city spread out in all directions from this original center, the core would become the central business district (CBD). As activities in the CBD and in the harbor increased, their competing claims for land would inevitably conflict. Large ships and faster turnaround capabilities have greatly reduced the number of ships and the length of berth required to handle a given tonnage, but they have also increased the need for a large area behind the berth for handling the tonnage by rail and road. Thus, relocation of the port to new land becomes unavoidable. Each new type of long-distance transportation has repeated this pattern.

Derived from text

*Airport Planning; Position (Location); Relocation; Economics; Commerce; Air Transportation*

19990099403 Hiroshima Univ., Graduate School for International Development and Cooperation, Japan

Location of International Airport and Regional Development: Socio-Economical Analyses of the Preferences of Travelers, Air Transport Industries and Regions

Tsujimoto, Katsuhisa, Hiroshima Univ., Japan; Toda, Tsunekazu, Hiroshima Univ., Japan: The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 56p; In English; See also 19990099396

Report No.(s): Paper-1043; Copyright Waived; Avail: CASI; A04, Hardcopy; A03, Microfiche

The aviation network is largely transforming. In order to cope with the change of the aviation network, what kind of aviation policy is required for each region? Briefly, the aviation network is transforming as follows: First, the role of the airport for the development of cities and regions is rapidly growing. Now, airport can be regarded as "Regional Minimum" facilities, that is to say, one of essential infrastructures for the regional development. Airports are the gateway for travelers, the terminal for the high

value added freights, and the interchange of information. So, after a series of political and economical change, which include the end or the ease of the Cold War, economic growth especially in East Asia, globalization of economic activities, the role of airports has been enlarged as "Regional Minimum" facilities. Second, the composition of international aviation network has changed significantly. Three factors, which are rapid increase of demand for air transportation especially in Asia, recent improvement of aircraft's performance and the liberalization, are proceeding simultaneously. Consequently, the international aviation network will become "Best Mixed Network (BMN)". BMN is the network in which the Hub-and-Spoke Network (HAS) and the Direct Flight Network (DFN) are mixed best. Third, the international aviation fare system is changing greatly. Today, most of local airports in Japan do not have an international direct fare. However, the opportunities for international travelers to arrive or depart to/from local airports will increase the spread of the international direct fare, because of the intensification of competition. In order to cope with the change of the aviation network, what kind of aviation policy is required for each region? In other words, how to improve international airport in each region? How managed it? In addition, how to use it to activate regional economy and society? Objective criteria and indices are required for this complicated issues.

Derived from text

*Position (Location); Airports; Air Transportation; Economics; Industries; Politics*

**19990099404 Instituto Tecnologico de Aeronautica, Sao Paulo, Brazil**

A Simulation Technique for Analysis of Brazilian Airport Passenger Terminal Buildings

Alves, Claudio Jorge Pinto, Instituto Tecnologico de Aeronautica, Brazil; de Almeida, Paulo Marcos Santo, Instituto Tecnologico de Aeronautica, Brazil; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 6p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

The Air Transport industry continues to show signs of improving health. From 31,000 thousands passengers carried in the world civil air transport in 1950 to 1,258 million passengers in 1995. International Air Transport Association (IATA) expects total international scheduled passengers traffic to grow at 6.6% for the five-year period ending in 1998. Boeing's forecast for the cargo industry predicts a 6.6% annual growth rate. Airbus predicts an annual growth rate of 5.1% in worldwide revenue passenger kilometers. The trends are to keep the growth rates positively. In Brazil, to the next four-year period, investments are estimated in more than US\$ 2,500 million in the air transport industry. The movement in the busiest Brazilian airport, the International Sao Paulo/Guarulhos, went beyond 12 million passengers in 1997. Airport systems are normally near its saturation point: Belém, Fortaleza, Natal, Porto Alegre and Rio Branco Airport Terminal Buildings are under construction. The costs to extend or to refurbish some installation are too high! There are financial restrictions and environmental oppositions to enlarge those infrastructures. There are, more and more, a single choice to increase productivity, make more with less. The usual procedures for designing and operating airport passenger terminal buildings normally create to either high operating and maintenance costs or passenger conflicts. Many researches have been conducted intending a reduction of "door-to-door" travel time, which contains an increasing proportion of ground time as compared with actual flight time. As the aviation industry evolved, it became increasingly competitive and far more volatile. For the airport planner, this has meant designing terminals that could reach obsolescence before leaving the drawing board. In order to be able to compare a number of design alternatives and examine the "what if?" scenarios that are vital in today's environment the utilization of simulation models is suggested. This paper develops a simulation technique that helps the designer "to see in operation" his solutions for existing problems or to analyze layout options as a function of previewed scenarios, thus futures conflicts can be predicted and avoided.

Derived from text

*Simulation; Procedures; Air Transportation; Aircraft Industry; Commercial Aircraft; Maintenance; Operating Costs*

**19990099405 Kansai Gaidai Univ., Hirakata, Japan**

Multimodal Airport Access in Japan

Kato, Kazusei, Kansai Gaidai Univ., Japan; Sakakibara, Yasuo, Osaka Univ., Japan; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 15p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

In this paper, the authors intend to analyze factors that affect access modal choice in Japan. Most airports, excepting very small ones, in Japan have multimodal access: by bus and private automobile. A few large airports-Kansai, Narita, Haneda, Sihon-Chitose, Fukuoka and Osaka - have rail access also. We weighted quantitatively relative significance of money cost, travel time and other factors that were assumed to determine the modal choice. Because of limitations of available data and because of differences among individual airports, our cross-sectional approaches to the access share had somewhat lower fits than we had hoped for. Nevertheless our findings seem to have a few policy implications. For example our research revealed that parking charges at

airports were a crucial factor in access modal choice in Japan and so, if one wants to increase the patronage of mass transport, increase in parking charges for private automobile seems most effective. We want to comment on other factors also.

Author

*Airports, Classifications; Construction; Environment Protection; Policies; Subdivisions*

19990099406 Ministerie van de Vlaamse Gemeenschap, Brussels, Belgium

Planning Surface Access Provision at Major Airports

DeRyck, Luc, Ministerie van de Vlaamse Gemeenschap, Belgium; Jones, Roger, West Sussex County Council, UK; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 9p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Air travel in Europe is growing at a faster rate than any other means of transport, typically 6% per annum despite economic recessions in several countries. The recent deregulation of air transport in Europe could well accelerate this process. However, surface transport systems which serve the airports, particularly roads, are not keeping up with this increased demand for capacity. This is not just a question of the money not being available for investment in new roads. Many governments, national and local, are questioning the sustainability of unconstrained road building and in some cases are already acting upon this by cutting their construction programmes. It is within this context that the Airport Regions Conference, a Pan-European network of regional councils, was founded in November 1995. All the regional councils have the common feature of a major international airport within their boundaries, often serving a city outside of the regional boundary. The network has set up four working groups to address issues arising from the day to day operations of major airports and the forward planning of airport expansion. One of these groups is dealing with surface access to the airport and this presentation is submitted on behalf of this group with its agreement.

Author

*Airports, Planning, Construction, Economics; Roads; Air Transportation*

19990099408 Nebraska Univ., Dept. of Public Administration, Omaha, NE USA

Airport Financing and User Charge Systems in the USA

Bartle, John R., Nebraska Univ., USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 14p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper examines the financing of U.S. public airports in a turbulent era of change, and projects toward the future. It begins by briefly outlining historical patterns that have changed the industry, and airport facilities in particular. It then develops basic principles of public finance as applied to public infrastructure, followed by the applicable principles of management. Following that, the current airport financing system is analyzed and contrasted with a socially optimal financing system. A concluding section suggests policy reforms and their likely benefits. The principles of finance and management discussed here are elementary. However, their implications are radical for U.S. airport policy. There is a great deal of room to improve the allocation of aviation infrastructure resources. The application of these basic principles makes it evident that in many cases, current practice is wasteful, environmentally unsound, overly costly, and inequitable. Future investments in public aviation capital will continue to be wasteful until more efficient pricing systems are instituted. Thus, problem in the U.S. is not one of insufficient investment in airport infrastructure, but investment in the wrong types of infrastructure. In the U.S., the vast majority of publicly-owned airports are owned by local governments. Thus, while the federal government had a great deal of influence in financing airports, ultimately these are local decisions. The same is true with many other public infrastructure issues. Katz and Herman (1997) report that in 1995, U.S. net public capital stock equaled almost \$4.6 trillion, 72% of which (\$3.9 trillion) was owned by state and local governments, most of it in buildings, highways, streets, sewer systems, and water supply facilities. Thus, public infrastructure finance is fundamentally a local government issue, with implications for federal and state governments in the design of their aid programs.

Author

*Airports, Finance, Highways, Policies*

19990099411 Lemaitre (Anne), Papeete, French Polynesia

The Development of Performance Indicators for Airports: A Management Perspective

Lemaitre, Anne, Lemaitre (Anne), French Polynesia; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 16p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

The literature in general management has argued that financial performance indicators need to be complemented by non financial performance indicators. Thus in accounting it has been argued that researchers should attempt to develop non-financial

measures of manufacturing performance, such as productivity, quality, and inventory costs. Later following this theme, Kaplan and Norton (1992) developed the balanced score card which included not only financial measures but also indicators from the customer, internal business process and innovation perspective. This paper will examine the measurement of airport performance from three general management perspectives: the financial perspective, the marketing perspective and the operational perspective.

Author

*Airports; Marketing; Productivity; Financial Management*

**19990099413 HNTB Architects Engineering Planners, Fort Worth, TX USA**

Austin Bergstrom West Loop Cable System

Pillar, Roxanne L., HNTB Architects Engineering Planners, USA; Eisenrich, Brian L., Southwest Carlson Associates, USA; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 10p; In English; See also 19990099396

Report No(s): Paper-990-Rev; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Robert Mueller Airport has served the City of Austin, Texas, USA since the 1930's. Unable to purchase land needed to expand runway capacity for long-term aviation demand at the present Muller Airport, the issue was put to public vote. Voter referendum November 3, 1987, and May 1, 1993, confirmed the decision to develop a new commercial airport. Numerous studies identified the active Bergstrom Air Force Base as the preferred site. Options of joint military-civilian use of the Air Force base were explored. In July 1991, a United States Congressional commission formally recommended that the base be closed. On August 1, 1991, the Austin City Council passed a resolution formally designating Bergstrom as the preferred site for a new commercial airport. The site is located 7 miles southeast of the Austin central business district but within the city limits. At the Federal Aviation Administration (FAA), this project had to be submitted on fiscal year planning budgets and assigned a Congressional budget line item number. The budget line item number is used for the annual budget submittal to the USA (U.S.) Congress. Projects are prioritized and funded as monies are available. A project might go through the annual budget process as many as five times before being discarded or funded. Documentation of the problems and justification for the proposed action had to be submitted to Washington, D.C. and prioritized with other projects from across the USA of America. The City of Austin, Texas, made a commitment to provide portions of the funding to balance the federal government investment. After the project successfully maneuvered this process, project authorization was given by Congress and monies assigned to the project. The FAA Southwest Regional Office staff was given project authorization and the assignment to proceed with the design. The Airway Facilities Division manages the airport facility projects built by the FAA including the loop cable system. The conversion of an existing military air force base to a joint use or non-military airport poses special considerations. Issues and concerns become twofold with a planned additional parallel runway. Existing navigational aids (navaids) such as instrument landing systems, approach light systems, radar facilities, and remote radio sites must be replaced and/or upgraded and new navaids planned, designed and installed. Ultimately all components of the air traffic capabilities of the airport must be controlled and monitored at the airport traffic control tower (ATCT). The navaids are controlled and monitored at the ATCT through a loop cable control system. The configuration and routing of a duct bank system to support the loop cable system is based on mandatory and non-mandatory FAA criteria, in-house review of the recommendations and coordination with the sponsor (airport owner). Austin Bergstrom International Airport is the only new major activity airport under construction in the USA at this time. In addition to converting a former military base to a commercial airport, this project includes coordination of loop cable system and joint use of the system by the FAA and the City of Austin. This joint use has operations and financial implications beyond the usual relationship of FAA to sponsor.

Derived from text

*Air Traffic; Airport Towers; Airports; Budgeting; Construction; Instrument Landing Systems; Navigation Aids*

**19990099414 Tarbiat Modares Univ., Dept. of Civil Engineering, Tehran, Iran (Islamic Republic of)**

An Optimum Resource Allocation Model for Airport Passenger Terminals

Parizi, Mahmoud Saftarzadeh, Tarbiat Modares Univ., Iran (Islamic Republic of); The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 2; 10p; In English; See also 19990099396; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

There has been little research to involve optimization theory in the planning, design, and operation of airport PTBs. The only exception is development of a design methodology, based on the heuristic modelling technique, to produce an optimum terminal design (1). The methodology is composed of three major algorithms: facility sizing algorithm, the load assignment algorithm, and the facility layout algorithm. This methodology determines the minimum amount of areal spaces first, and second the loads are assigned to the facilities in such a way that transport cost, expressed as the sum of the products of passenger flow times distance, is at minimum. Then the facilities are located relative to each other in such a manner that the transport cost is also at a minimum. The second and third steps are iterated until an optimum design has been obtained. The methodology is very useful in planning

and design in terms of optimum concept selection. It does not deal with the PTB components in detail in terms of operating characteristics and stochastic demand. In this research, the whole PTB is considered as a system in which labor, capital, and services are deployed to produce certain services to passengers. The function of this complex system may be seen as taking a passenger and providing some services to that passenger. This provision of services is associated with some cost to operators as well as passengers. For example, operating and maintenance costs which constitute a major portion of the total cost, has been almost always neglected in the current planning and design procedures. Operating and maintenance costs can be reduced by a reduction in level of service, especially at peak periods, but at some cost to the passenger. The least cost solution may not be always the best solution for the passenger. On the other hand, terminal configurations that supposedly offer high levels of service may be expensive to operate. Those costs will be ultimately paid by the traveller either through higher fares, or other user charges. Optimizing the associated costs with the PTB operation is the subject of the optimization model discussed in this paper.

Author

*Research; Terminal Facilities; Airports; Optimization; Models; Design Analysis; Passengers; Layouts*

19990103064 National Aerospace Lab., Tokyo Japan

Parallel Computations of Incompressible Viscous Flow in a Lid-Driven Square Cavity and Program Performance on the NWT Computer System

Hatayama, S.; Oct. 1998; 48p; In English

Report No.(s): PB99-169633; NAL-TR-1363T; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

This paper reports parallel computations of incompressible viscous flow in a lid-driven square cavity on the NWT computer system. In order to obtain numerical solutions of this flow, consistent finite-difference approximations on non-staggered grids and four iterative solution methods are used. Computations are performed on the Reynolds number range of  $Re = 0$  to approximately 100,000, and effect of the Reynolds number, number of processing element (pe) in parallel processing, solution method and grid size on the computational results are examined. Actual rates of the parallelized square cavity programs on the NWT computer system are measured, and two characteristic parameters of these programs are estimated for the cases that the actual rate is considered as a function of pe and that the actual rate is considered as a function of the grid size. Measurements of the maximum actual rate and estimations of the speedup and efficiency against pe on the NWT computer system are indicated as well.

NTIS

*Parallel Processing (Computers); Incompressible Flow; Cavities; Viscous Flow; Computer Systems Performance*

19990104344 Institute for Human Factors TNO, Soesterberg, Netherlands

The Development of Training Simulator Specifications *Interim Report De Ontwikkeling van Specificaties voor Trainingssimulatoren*

Versteegen, D. M. L.; Institute for Human Factors TNO, Netherlands; Barnard, Y. F.; Institute for Human Factors TNO, Netherlands; vanRooij, J. C. G. M.; Institute for Human Factors TNO, Netherlands; Jun. 17, 1999; 40p; In Dutch

Contract(s)/Grant(s): B98-051; TNO Proj. 730.1

Report No.(s): TD99-0321; TM-99-8006; Copyright; Avail: Issuing Activity, Hardcopy

Specifications for training simulators should be derived from training needs: which features and functions of the real system should be simulated depends on the tasks to be trained. Additional facilities are required for instructional purposes. Issues that should be addressed include: simulator coverage, integration in overall training, adaptation to target groups of trainees and to the needs of individual trainees, instruction, guidance and feedback, assessment of trainees, quality assurance and evaluation of training, adaptation of training and/or scenarios, instructor support and lay down specifications and specification process. Apart from ensuring that these issues are addressed, a methodology for the development of training simulator specifications should provide structure and guidance, support information, resource and process management and provide opportunities for quality control and the storage and reuse of information. A methodology for the development of functional specifications for training simulators has been developed in the context of a European defence research project (MASTER project, EUCLID RTP 1.1.1). The MASTER methodology seems to meet most of the requirements: it offers a clear structure of steps and decisions to be taken and it provides a framework to store and organize knowledge available from experts and research literature and make it concrete and applicable during the development of training simulator specifications. The iterative aspect of the development process is, however, not sufficiently supported. Further research will be directed towards the development, implementation and validation of support facilities to help users to take process-oriented decisions and to organize their own iterative development process.

Author

*Training Simulators; Product Development; Resources Management; Functional Design Specifications*

19990104354 Air Force Research Lab., Materials and Manufacturing Directorate, Wright-Patterson AFB, OH USA  
Testing of Aircraft Runway Ice Control Products. Materials Compatibility Final Report, Oct. 1997 - Oct. 1998  
Gulley, Lee; Oct. 1998; 195p; In English

Contract(s)/Grant(s): Proj-4349

Report No.(s): AD-A364904; AFRL-ML-WP-TR-1999-4040; AFRL/MLSA-98-137; No Copyright; Avail: CASI; A09, Hardcopy; A03, Microfiche

New commercial formulations of runway ice control products have recently made their way onto military and commercial aircraft runways. These new ice control products are purchased to AMS/SAE (Aerospace Materials Specifications/ Society of Automotive Engineers) 1431 and 1435. These products have not been tested for compatibility with a number of aircraft materials, many of which are common to both commercial and military aircraft. In addition, there are some materials that are unique to military aircraft; infrared windows for example for which no compatibility testing had been done, to fill this knowledge gap, AFRL/MLSA undertook a study to evaluate the compatibility of these products with aerospace materials. The compatibility testing performed on these products exceeds the AMS/SAE specification requirements. This report documents AFRL/MLSA'S effort to identify possible problems for both commercial and military aircraft with new deicer/anti-icer materials not evident with the previously used ice control materials.

DTIC

*Runways; Deicers; Specifications; Requirements*

19990105728 Institute for Human Factors TNO, Soesterberg, Netherlands

Flight Simulation: Visual-vestibular Stimulation *Interim Report Vliegtuigsimulatie: Visueel-vestibulaire Stimulatie*

Hosman, R. J. A. W., Institute for Human Factors TNO, Netherlands; Bles, W., Institute for Human Factors TNO, Netherlands; May 11, 1999; 32p; In Dutch

Contract(s)/Grant(s): A98/KLu/310; TNO Proj. 789.3

Report No.(s): TD99-0040; TM-99-A034; Copyright: Avail: Issuing Activity, Hardcopy

Simulation in general and aircraft simulation in particular will obtain a wider application in the future. Fighter simulation, however, lags behind this development. This is primarily a result of the limited capacity of the presently used training simulators with Stewart motion platforms which do not provide the fighter pilot with the required visual-vestibular stimulation during high-G manoeuvres characteristic of the fighter operation. In this report, a survey of the technical facilities, visual display systems and motion systems, available for flight simulation is presented. In addition, the requirements for the visual-vestibular stimulation of the fighter pilot during training simulation are discussed. Based on this overview, it turns out that the lack of G loading during simulation of manoeuvres is the limiting factor in the present fighter simulation. This limits the military simulation to procedure training in fixed-base simulators. On account of these considerations, a new concept for a motion system with six degrees of freedom and the ability to generate a lasting G-loading is introduced. This Desdemona concept is considered a suitable research tool to develop the essential experience and knowledge for the simulation of high-G manoeuvres. The report concludes with some recommendations for supporting research.

Author

*Flight Simulation; Vestibules; Training Simulators; Display Devices*

## 10 ASTRONAUTICS

*Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; space communications; spacecraft communications; command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.*

19990094229 NASA Langley Research Center, Hampton, VA USA

Cyclic Cryogenic Thermal-Mechanical Testing of an X-33/RLV Liquid Oxygen Tank Concept

Rivers, H. Kevin, NASA Langley Research Center, USA; September 1999; 18p; In English; Original contains color illustrations

Contract(s)/Grant(s): RTOP 242-23-02-13

Report No.(s): NASA/TM-1999-209560; L-17818; NAS 1.15:209560; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

An important step in developing a cost-effective, reusable, launch vehicle is the development of durable, lightweight, insulated, cryogenic propellant tanks. Current cryogenic tanks are expendable so most of the existing technology is not directly applicable to future launch vehicles. As part of the X-33/Reusable Launch Vehicle (RLV) Program, an experimental apparatus

developed at the NASA Langley Research Center for evaluating the effects of combined, cyclic, thermal and mechanical loading on cryogenic tank concepts was used to evaluate cryogenic propellant tank concepts for Lockheed-Martin Michoud Space Systems. An aluminum-lithium (Al 2195) liquid oxygen tank concept, insulated with SS-1171 and PDL-1034 cryogenic insulation, is tested under simulated mission conditions, and the results of those tests are reported. The tests consists of twenty-five simulated Launch/Abort missions and twenty-five simulated flight missions with temperatures ranging from -320 F to 350 F and a maximum mechanical load of 71,300 lb. in tension.

Author

*Cyclic Loads; Storage Tanks; Propellant Tanks; Load Tests; Load Testing Machines; Flight Simulation*

19990100665 Iowa State Univ. of Science and Technology, Dept. of Aerospace Engineering and Engineering Mechanics, Ames, IA USA

Entry Guidance for the Reusable Launch Vehicle. *Final Report, 5 Jan. 1997 - 6 Jul. 1999*

Lu, Ping, Iowa State Univ. of Science and Technology, USA; [1999]; 58p; In English

Contract(s)/Grant(s): NAG8-1289; No Copyright; Avail: CASI; A04, Hardcopy; A01, Microfiche

The X-33 Advanced Technology Demonstrator is a half-scale prototype developed to test the key technologies needed for a full-scale single-stage reusable launch vehicle (RLV). The X-33 is a suborbital vehicle that will be launched vertically, and land horizontally. The goals of this research were to develop an alternate entry guidance scheme for the X-33 in parallel to the actual X-33 entry guidance algorithms, provide comparative and complementary study, and identify potential new ways to improve entry guidance performance. Toward these goals, the nominal entry trajectory is defined by a piecewise linear drag-acceleration-versus-energy profile, which is in turn obtained by the solution of a semi-analytical parameter optimization problem. The closed-loop guidance is accomplished by tracking the nominal drag profile with primarily bank-angle modulation on-board. The bank-angle is commanded by a single full-envelope nonlinear trajectory control law. Near the end of the entry flight, the guidance logic is switched to heading control in order to meet strict conditions at the terminal area energy management interface. Two methods, one on ground-track control and the other on heading control, were proposed and examined for this phase of entry guidance where lateral control is emphasized. Trajectory dispersion studies were performed to evaluate the effectiveness of the entry guidance algorithms against a number of uncertainties including those in propulsion system, atmospheric properties, winds, aerodynamics, and propellant loading. Finally, a new trajectory-regulation method is introduced at the end as a promising precision entry guidance method. The guidance principle is very different and preliminary application in X-33 entry guidance simulation showed high precision that is difficult to achieve by existing methods.

Author

*X-33 Reusable Launch Vehicle; Recoverable Launch Vehicles; Guidance (Motion); Flight Control; Trajectory Control; Vertical Takeoff; Entry Guidance (SIS); Spacecraft Reentry*

19990102412 NASA Marshall Space Flight Center, Huntsville, AL USA

Guidance and Control Concepts for the X-33 Technology Demonstrator

Dukeman, Gregory A., NASA Marshall Space Flight Center, USA; Gallaher, Michael W., NASA Marshall Space Flight Center, USA, 1998; In English; 1998 Guidance and Control, 4-8 Feb. 1998, Breckenridge, CO, USA; Sponsored by American Astronomical Society; Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

The X-33 technology demonstrator is a suborbital precursor to the Reusable Launch Vehicle (RLV) with first flight planned for summer of 1999. The flight test program will include about 15 flights originating from Edwards Air Force Base, California, each with widely varying flight profiles in order to test new thermal protection system (TPS) materials, structures, and linear aerospike engines. The first flights will be relatively short range flights with about a 300 nmi range, maximum Mach number of 7, maximum altitude of 190,000 feet, whereas the latter flights will cover about 800 nmi range, with max altitude of about 260,000 feet and max Mach of about 15. The guidance algorithms must be flexible enough to accommodate these various profiles and to adapt to severe off-nominal dispersions, such as early engine failure (partial or total) where possibly more than half the thrust is lost. An onboard real-time performance monitor will be used to assess the viability of the nominal landing site as well as alternate landing sites that would potentially be used in extreme off-nominal conditions. During ascent, a single entry guidance-related parameter, which is easy to calculate, is used to assess the viability of the nominal landing site as well as alternate landing sites. Real-time adjustment of the stored ascent attitude profile will be performed, as required, to maximize the probability of making it to the nominal landing site. Numerical results are given for various engine-out cases to illustrate the adaptability of the performance monitor.

Author

*Control Theory; Aircraft Guidance; Aircraft Control; X-33 Reusable Launch Vehicle*

19990105819 NASA Marshall Space Flight Center, Huntsville, AL USA

The Lifting Body Legacy...X-33

Barret, Chris, NASA Marshall Space Flight Center, USA; [1999]; In English; 37th Aerospace Sciences, 11-14 Jan. 1999, Reno, NV, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA; Copyright: Avail: Issuing Activity, Hardcopy, Microfiche

NASA has a technology program in place to enable the development of a next generation Reusable Launch Vehicle that will carry our future payloads into orbit at a much-reduced cost. The VentureStar, Lifting Body (LB) flight vehicle, is one of the potential reusable launch vehicle configurations being studied. A LB vehicle has no wings and derives its lift solely from the shape of its body, and has the unique advantages of superior volumetric efficiency, better aerodynamic efficiency at high angles-of-attack and hypersonic speeds, and reduced thermal protection system weight. Classically, in a ballistic vehicle, drag has been employed to control the level of deceleration in reentry. In the LB, lift enables the vehicle to decelerate at higher altitudes for the same velocity and defines the reentry corridor which includes a greater cross range. This paper outlines the flight stability and control aspects of our LB heritage which was utilized in the design of the VentureStar LB and its test version, the X-33. NASA and the U.S. Air Force have a rich heritage of LB vehicle design and flight experience. In the initial LB Program, eight LB's were built and over 225 LB test flights were conducted through 1975. Three LB series were most significant in the advancement of today's LB technology: the M2-F; the HL-10; and the X-24 series. The M2-F series was designed by NASA Ames Research Center, the HL-10 series by NASA Langley Research Center, and the X-24 series by the U. S. Air Force. LB vehicles are alive again today with the X-33, X-38, and VentureStar.

Author

*Angle of Attack; Deceleration; Drag; Launch Vehicle Configurations; Lifting Bodies; X-33 Reusable Launch Vehicle; X-38 Crew Return Vehicle*

19990100963 Smithsonian Astrophysical Observatory, Cambridge, MA USA

In-Space Transportation with Tethers. *Final Report, 1 Sep. 1996 - 15 Mar. 1999*

Lorenzini, Enrico C., Smithsonian Astrophysical Observatory, USA; September 1999, 206p; In English

Contract(s)/Grant(s): NAG8-1303; No Copyright; Avail: CASI; A10, Hardcopy; A03, Microfiche

Any analysis of electrodynamic tethers for Space Station applications will soon arrive at the conclusion that currents on the order of 10 A are required. For power generation, we have to foresee needs of several kilowatts even for an emergency backup system. For reboost, we need thrust forces on the order of a Newton, due to the large aerodynamic drag of the Station. In addition, we are restricted by the need to keep perturbations to the Station environment to a minimum. Very long tethers are ruled out by this condition, as they would move the system's center of gravity too much and pose additional operational problems when the Station is docking with other spacecraft. It is easy to show that "standard" tether systems, such as TSS-1, which rely on a large spherical surface to collect electron current from the ionosphere, are unsuitable for ISS applications. A study conducted by MSFC into the possible use of the TSS - I/R system on the Space Station came to the conclusion that it did not make sense. A quick calculation, using the 10 A benchmark, shows why. TSS-LR collected 1 A, while the satellite was biased to 1.5 kV. This was twice what had been predicted. Even so, the current collected by the satellite was observed to increase only as the square root of the bias voltage. Thus, to achieve 10 A with the TSS-1 system under the same (daytime) conditions would require a bias voltage of 150 kV, or a tether length of over 850 km! Going to a larger surface would help some, but there is a strong law of diminishing returns for that route. Even if very large spheres were to be allowed (say of 8 m radius), which might achieve useful power levels during optimal conditions of daytime plasma densities with a tether 10 km long, they would suffer from the other Achilles heel of passive spherical collectors: a strong drop in the current (and power goes as the square of the current), as the low plasma densities are encountered during the third of the orbit which is in the Earth's shadow.

Derived from text

*Tethering; Electrodynamics; International Space Station; Transportation; Operational Problems; Aerodynamic Drag*

19990103066 National Aerospace Lab., Tokyo Japan

Conceptual Study for Improving the Efficiency of the Return Flight Path Design of the Space Shuttle

Hara, Y.; Ito, F.; Suematsu, S.; Oct. 1998; 36p; In Japanese; Portions of this document are not fully legible

Report No.(s): PB99-169591; NAL-TR-1365; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The return flight path of the space shuttle used to be designed through parametric iteration to reduce the gaps at the interface points of the two adjacent flight paths, of different flight phases of reentry, TAEM (Terminal Area Energy Management) and AL (Approach Landing), which are maneuvered by the guidance program. This research shows that the return flight path can be deduced from the gliding performance which is determined by the lift/drag ratio (L/D), where L/D is controlled by the angle of

attack, the speed brake angle and the bank angle, and that an algorithm to determine the return flight path corridor depending on the gliding capability of the vehicle can be derived.

NTIS

*Flight Paths; Space Shuttles; Spacecraft Reentry; Aircraft Approach Spacing; Approach Control; Reentry Guidance; Reentry Vehicles; Gliding; Glide Paths; Return to Earth Space Flight*

19990089842 NASA Wallops Flight Facility, Wallops Island, VA USA

Overview of the NASA Wallops Flight Facility Mobile Range Control System

Davis, Rodney A., NASA Wallops Flight Facility, USA; Semancik, Susan K., NASA Wallops Flight Facility, USA; Smith, Donna C., NASA Wallops Flight Facility, USA; Stancil, Robert K., NASA Wallops Flight Facility, USA; 1999; 11p; In English; Telemetering, Oct. 1999, Nevada, USA; No Copyright; Avail: Issuing Activity, Hardcopy

The NASA GSFC's Wallops Flight Facility (WFF) Mobile Range Control System (MRCS) is based on the functionality of the WFF Range Control Center at Wallops Island, Virginia. The MRCS provides real time instantaneous impact predictions, real time flight performance data, and other critical information needed by mission and range safety personnel in support of range operations at remote launch sites. The MRCS integrates a PC telemetry processing system (TELPro), a PC radar processing system (PCDQS), multiple Silicon Graphics display workstations (IRIS), and communication links within a mobile van for worldwide support of orbital, suborbital, and aircraft missions. This paper describes the MRCS configuration; the TELPro's capability to provide single/dual telemetry tracking and vehicle state data processing; the PCDQS' capability to provide real time positional data and instantaneous impact prediction for up to 8 data sources; and the IRIS' user interface for setup/display options. With portability, PC-based data processing, high resolution graphics, and flexible multiple source support, the MRCS system is proving to be responsive to the ever-changing needs of a variety of increasingly complex missions.

Author

*Flight Control; Telemetry; Trajectory Control; Real Time Operation; Flight Characteristics; Tracking Problem; Tracking (Position); Range Safety*

## 11 CHEMISTRY AND MATERIALS

*Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; propellants and fuels; and materials processing.*

19990097465 Johns Hopkins Univ., Chemical Propulsion Information Agency, Columbia, MD USA

Technology Awareness Workshop on Active Combustion Control (ACC) in Propulsion Systems: JANNAF Combustion Subcommittee Workshop

Fry, Ronald S., Editor, Johns Hopkins Univ., USA; Gannaway, Mary T., Editor, Johns Hopkins Univ., USA; Nov. 1997; 180p; In English; Active Combustion Control (ACC) in Propulsion Systems, 12 Nov. 1997, Cleveland, OH, USA; Sponsored by NASA, USA; See also 19990097466 through 19990097470

Contract(s)/Grant(s): SP0700-97-D-4004

Report No.(s): CPIA-PUBL-667; No Copyright; Avail: Issuing Activity (CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC), Hardcopy, Microfiche

A JANNAF Combustion Subcommittee Technology Awareness Seminar on Active Combustion Control (ACC) in Propulsion Systems' was held 12 November 1997 at the NASA Lewis Research Center (LeRC), Cleveland, Ohio. The objectives of the seminar were: 1) Define the need and potential of ACC to meet future requirements for gas turbines and ramjets; 2) Explain general principles of ACC and discuss recent successes to suppress combustion instabilities, increase combustion efficiency, reduce emission, and extend flammability limits; 3) Identify R&D barriers/needs for practical implementation of ACC; 4) Explore potential for improving coordination of future R&D activities funded by various government agencies. Over 40 individuals representing senior management from over 20 industry and government organizations participated. This document summarizes the presentations and findings of this seminar.

Author

*Active Control; Gas Turbines; Propulsion System Performance; Ramjet Engines; Research and Development; Conferences; Combustion Control*

19990097466 Innovative Scientific Solutions, Inc., Dayton, OH USA

Why Active Combustion Control?

Sturges, G. J., Innovative Scientific Solutions, Inc., USA; Technology Awareness Workshop on Active Combustion Control (ACC) in Propulsion Systems: JANNAF Combustion Subcommittee Workshop; Nov. 1997, pp. 5-39; In English; See also 19990097465; No Copyright; Avail: Issuing Activity (CPIA, 10630 Little Patuxent Pkwy., Suite 202, Columbia, MD 21044-3200 HC), Hardcopy, Microfiche

This presentation discusses the use of active combustion control in the gas turbine combustor. The combustion process in gas turbine combustors tends to instabilities. The causes of these instabilities, their severity, and possible adverse consequences were explained through examples in current engines. Combustion instability will probably dominate future gas turbine engines. To control these instabilities, a "Sword and Shield" approach was advocated; in which the shield is used to eliminate the instabilities, and the sword is used to exploit the instabilities to help achieve the engine goals. The preferred approach to eliminate the instabilities (shield), passive control is not robust, and is difficult to implement for frequencies of less than 500 Hz. However, Active Combustion Control, (ACC) in adaptive closed-loop form can control instabilities over a wide bandwidth, and can potentially serve as both a sword and shield. Use of Active control can improve mixing of fuel and air, and control a jet of fluid entering the combustor by changing the initial angle of the trajectory, and the cross-sectional shape. The active control can be applied to either the air or fuel/air jets. In manners like these, the use of Active Control can contribute directly to meeting engine goals, with respect to engine acceleration and can reduce emissions, improve mixing and enhance lean blow-out.

CASI

*Active Control; Air Jets; Combustion; Combustion Stability; Gas Turbine Engines; Stability*

19990087896 Beijing Univ. of Aeronautics and Astronautics, Beijing, China

Effects of Stretching Conditions on Forming Quality of Mirror Skins

Wan, Min, Beijing Univ. of Aeronautics and Astronautics, China; Zhou, Xian-Bin, Beijing Univ. of Aeronautics and Astronautics, China; Li, Xiao-Xing, Beijing Univ. of Aeronautics and Astronautics, China; Wu, Hui, Chengdu Aircraft Industrial Corp., China; Journal of Beijing University of Aeronautics and Astronautics; December 1998; ISSN 1001-5965; Volume 24, No. 6, pp. 654-657; In Chinese; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

On the basis of full consideration of the slip band appearing and the shape fixability of forming parts, reasonable conditions in stretch forming of airplane mirror skins have been determined by means of analysis of the effects of stretching velocity, geometrical dimensions of blank, geometrical parameters of dies and lubrication methods on forming quality. The results show that improving the deformation uniformity of sheet materials, delaying the appearance of slip band, and increasing the material deformation degree of the forming region are the main measures of working out the optimum process parameters and improving the forming quality of mirror skins.

Author

*Stretch Forming; Stretching; Metal Working; Aircraft Parts*

19990104383 National Renewable Energy Lab., Golden, CO USA

Metalcasting; Die Casting Copper Motor Rotors

Recca, Lee, National Renewable Energy Lab., USA; Jan. 29, 1999; 379p; In English

Report No.(s): DE00-003950; NREL/FS-330-25029; No Copyright; Avail: Department of Energy Information Bridge, Hardcopy

Decreased energy requirements, air emissions, production time, and operating costs are some of the benefits that will accrue to the metalcasting industry as a result of this new die casting technique. This fact sheet provides the details of this exciting new process for fabricating copper motor rotors.

NTIS

*Casting; Copper; Rotors; Fabrication*

## 12 ENGINEERING

*Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.*

19990089315 Kyushu Univ., Graduate School of Engineering, Fukuoka, Japan

Technology Reports of Kyushu University, Volume 72

May 1999; ISSN 0023-2718; 142p; In Japanese; See also 19990089316 through 19990089320; No Copyright; Avail: CASI; A07, Hardcopy; A02, Microfiche

This report contains the following: Design and basic considerations of contra-rotating axial flow pump, subsonic wind tunnel facility for Particle Image Velocimetry (PIV) and blade flutter experiments, an experimental study on mechanical behavior of concrete pier subjected to cyclic load, and measuring method of strain using wheatstone bridge.

Derived from text

*Design Analysis; Subsonic Wind Tunnels; Mechanical Properties*

19990097475 Naval Air Warfare Center, Aircraft Div., Patuxent River, MD USA

Testing and Proving the GBU-24 Laser guided Bomb from the US Navy's F-14 Aircraft

Cable, B., Naval Air Warfare Center, USA; Piranian, A., Naval Air Warfare Center, USA; Zaccardi, V., Naval Air Warfare Center, USA; 1998; 9p; In English; See also 19990097471; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

When the U.S. Navy identified the requirement to carry and employ the Texas Instruments-Raytheon GBU-24 Laser Guided Bomb (LGB) hard target penetrator from the F-14 aircraft, its weapons compatibility/certification engineers had to modify the weapons flight test process which had been in use for determination of F-14 and Air-to-Ground weapons compatibility. The process consisted of beginning tests at low mach/airspeed in straight and level flight, and continuing tests at incrementally greater speeds, through the highest Mach/airspeed and steepest flight path angles, with the acceptability of the weapon separation trajectory evaluated through film from aircraft-mounted cameras. The GBU-24, because of its large size and large deploying wing, had to be evaluated through an integrated test and evaluation process consisting of computational analyses, wind tunnel testing, ground testing, flight testing and photogrammetric analyses, used interdependently to determine the extent of aircraft/weapon compatibility. The test process ultimately led to the authorization for all F-14 variants to carry and employ two GBU-24's on fuselage carriage stations. In addition, the testing led to authorization for launching of an AIM7 Air to Air missile from a fuselage carriage station which was behind the LGB A/G weapons.

Author

*Acceptability; F-14 Aircraft; Flight Tests; Lasers; Air to Surface Missiles*

19990097477 Hunting Engineering Ltd., Ampthill, UK

The Use of a Tunable Plate to Simulate Carrier Responses When Subjected to Pyrotechnic Shock Loadings

Burnage, S. T., Hunting Engineering Ltd., UK; Richards, D. P., Hunting Engineering Ltd., UK; 1998; 6p; In English; See also 19990097471; Copyright; Avail: Issuing Activity (The Royal Aeronautical Society, 4 Hamilton Place, London, W1V 0BQ, UK), Hardcopy, Microfiche

Development of a pyrotechnic shock test facility capable of replicating the general response characteristics of a carrier vehicle, by use of a 'tunable plate' and triple barrelled gas gun is discussed.

Author

*Shock Tests; Test Facilities; Pyrotechnics; Explosives; Flight Vehicles; Flight Characteristics*

19990092713 Civil Aeromedical Inst., Oklahoma City, OK USA

Improving Pilot/ATC Voice Communication in General Aviation *Final Report*

Morrow, Daniel G., New Hampshire Univ., USA; Prinzo, O. Veronika, Civil Aeromedical Inst., USA; July 1999; 36p; In English  
Contract(s)/Grant(s): DTFB-92-96-P-54069, FAA Task AM-B-96-HRR-513

Report No.(s): DOT/FAA/AM-99/21; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

The influence of Air Traffic Control (ATC) instruction format (grouped vs. sequential presentation) and message length on General Aviation pilot communication was investigated in a simulated flight environment using the Civil Aeromedical Institute's (CAMI's) Basic General Aviation Research Simulator (BGARS). Prior to flying the simulator each pilot was provided with familiarization training, listened to and read back ATC messages spoken in either grouped or sequential format (depending on

their assigned treatment group), and completed a digit span test (a measure of short-term memory). While flying 2 missions in the simulator, 12 pilots heard recorded ATC messages that contained altitude and radio frequency information spoken in a grouped format (e.g., "descend and maintain forty-one hundred"), and 12 heard the same instructions spoken sequentially (e.g., "descend and maintain four thousand one hundred"). The amount of information in a message varied from 2 to 5 speech acts, including the aircraft identification. All pilots were instructed to read back and execute the ATC instructions. Readback errors and requests to clarify ATC messages were the primary measures of pilot communication. Readback strategies, such as whether pilots repeated instructions in the same format as issued by ATC, were also examined. We found only limited evidence that the grouped format improved pilot memory for ATC messages. In one analysis of requests for clarification, pilots who received grouped instructions produced fewer requests than did pilots who received the same instructions in sequential format, suggesting that they were less likely to misunderstand the ATC messages. Pilots who received grouped instructions were also more likely to read back the grouped instructions in sequential format, suggesting that prior experience with the sequential format influenced pilot communication in this study. ATC message length had a more clear-cut influence on pilot communication, with readback errors and requests for clarification increasing for longer messages.

**Author**

*Air Traffic Control; Messages; Voice Communication; Aircraft Communication; Automated Pilot Advisory System; Ground Support Equipment; Ground-Air-Ground Communication; Radio Communication*

19990098912 Physics and Electronics Lab, TNO, The Hague, Netherlands

*Video Transport for Military Vehicles Final Report*

Adriani, H., Physics and Electronics Lab, TNO, Netherlands; IntVelt, R., Physics and Electronics Lab, TNO, Netherlands;

Lubbers, W. J., Physics and Electronics Lab, TNO, Netherlands; July 1999; 40p; In English

Contract(s)/Grant(s): A98/KL/657; TNO Proj. 27542

Report No.(s): TD99-0229; FEL-99-A148; Copyright: Avail: Issuing Activity, Hardcopy

The need for a video bus within the military vehicle is evident. The flexibility of the crew will increase with the utilisation of video bus techniques. The introduction of digitised video and other information services requires standardised bus techniques. The combination of CATV and ATM provides a solution that fits for analogue and digital transmission of video information combined with other (high speed) data services.

**Author**

*Video Equipment; Data Transmission; Digital Television; Ground Effect Machines*

199900989076 Beijing Univ. of Aeronautics and Astronautics, Beijing, China

*Analysis of Axial-Flow Compressors Stall in Uniform and Distorted Inlet Flow*

Zhang, Ming-Chuan, Beijing Univ. of Aeronautics and Astronautics, China; Zhang, Jin, Beijing Univ. of Aeronautics and Astronautics, China; Tang, Di-Yi, Northwestern Polytechnical Univ., China; Journal of Beijing University of Aeronautics and Astronautics; December 1998; ISSN 1001-5965; Volume 24, No. 6, pp. 704-706; In Chinese; No Copyright; Avail: CASI; A01,

Hardcopy; A01, Microfiche

Using a row-to-row two-dimension nonlinear model, rotating stall parameters in a single rotor compressor are simulated, and compared well with the experimental data. The effects of inlet circumferential static distortion on the rotating stall in an one-stage compressor are investigated. Results show that there are no dramatic differences in stall parameters, whether the inlet flow is uniform or distorted. However, due to the interactions of inlet distortion, when stall occurs, the compressor displays not only a circumferential disturbance mode (stall wave), but also an axial disturbance mode (surge wave). Their coupling is an important factor for compressors' instability.

**Author**

*Axial Modes; Compressors; Turbocompressors; Rotating Stalls; Compressor Rotors*

19990097957 Kyushu Univ., Faculty of Engineering, Fukuoka, Japan

*Numerical Simulation of Shock Wave/Boundary Layer Interaction Including High Temperature Effect*

Matsumoto, Akira, Kyushu Univ., Japan; Aso, Shigeru, Kyushu Univ., Japan; Technology Reports of Kyushu University; Nov. 1997; ISSN 0023-2718; Volume 70, No. 6, pp. 637-642; In Japanese; No Copyright; Avail: Issuing Activity, Hardcopy, Microfiche

Aerodynamic heating in an unsteady shock reflection process by a wedge is numerically simulated. A shock wave/boundary layer interaction occurs at a corner when the shock Mach number is small, and the angle of the wedge is large. Numerical simulations are carried out in the case where the freestream temperature is very high and, shock Mach number is not so high. Hence, the process of dissociation and recombination of gas molecules is considered in this research. Energy transfers among each

internal energy modes are neglected. One temperature model is used in this study. A large amount of heat transfer from fluid to wall and a large rise in the wall pressure are observed at the point that the separated boundary layer reattaches to the wall.

**Author**

*Boundary Layers; Energy Transfer; Gas Dissociation; High Temperature; Shock Wave Interaction; Temperature Effects; Aerodynamic Heating; Wedges*

**19990104324 AYT Corp., Cleveland, OH USA**

Comparison of Two-Equation Turbulence Models for Prediction of Heat Transfer on Film-Cooled Turbine Blades

Garg, Vijay K., AYT Corp., USA; Ameri, Ali A., AYT Corp., USA; Numerical Heat Transfer, 1997, Volume 31, Pt. A, pp. 347-371; In English

Report No.(s): ASME Paper 97-GT-024; Copyright: Avail: Issuing Activity, Hardcopy, Microfiche

A three-dimensional Navier-Stokes code has been used to compute the heat transfer coefficient on two film-cooled turbine blades, namely, the VKI rotor with six rows of cooling holes, including three rows on the shower head and the C3X vane with nine rows of holes, including five rows on the shower head. Predictions of heat transfer coefficient at the blade surface using three two-equation turbulence model specifically, Coakley's  $q$ - $\omega$  model, Chien's  $k$ - $\epsilon$  model and Wilcox's  $k$ - $\omega$  model with Menter's modifications, have been compared with the experimental data of Camci and Arts for the VKI rotor, and of Hylton et al. for the C3X vane along with predictions using the Baldwin-Lomax (B-L) model taken from Garg and Gaugler. It is found that for the cases considered here the two equation models predict the blade heat transfer somewhat better than the B-L model except immediately downstream of the film-cooled holes on the suction surface of the VKI rotor, and over most of the suction surface of the C3X vane. However, all two-equation models require 40% more computer core than the B-L model for solution, and while the  $q$ - $\omega$  and  $k$ - $\epsilon$  models need 40% more computer time than the B-L model the  $k$ - $\omega$  model requires at least 65% more time because of the slower rate of convergence. It is found that the heat transfer coefficient exhibit a strong spanwise as well as streamwise variation for both blades and all turbulence models.

**Author**

*Convergence; Heat Transfer; K-Epsilon Turbulence Model; Mathematical Models; Navier-Stokes Equation; Rotors; Turbine Blades; Turbulence Models; Computational Fluid Dynamics; Film Cooling; Airfoils; Compressible Flow; Baldwin-Lomax Turbulence Model*

**19990102963 NASA Glenn Research Center, Cleveland, OH USA**

Instrumentation Working Group Summary

Zaller, Michelle, NASA Glenn Research Center, USA; Miake-Lye, Richard, Aerodyne Research, Inc., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 179-186; In English; See also 19990102951; No Copyright: Avail: CASI, A02, Hardcopy; A03, Microfiche

The Instrumentation Working Group compiled a summary of measurement techniques applicable to gas turbine engine aerosol precursors and particulates. An assessment was made of the limits, accuracy, applicability, and technology readiness of the various techniques. Despite advances made in emissions characterization of aircraft engines, uncertainties still exist in the mechanisms by which aerosols and particulates are produced in the near-field engine exhaust, to adequately assess current understanding of the formation of sulfuric acid aerosols in the exhaust plumes of gas turbine engines, measurements are required to determine the degree and importance of sulfur oxidation in the turbine and at the engine exit. Ideally, concentrations of all sulfur species would be acquired, with emphasis on  $\text{SO}_2$  and  $\text{SO}_3$ . Numerous options exist for extractive and non-extractive measurement of  $\text{SO}_2$  at the engine exit, most of which are well developed.  $\text{SO}_2$  measurements should be performed first to place an upper bound on the percentage of  $\text{SO}_2$  oxidation. If extractive and non-extractive techniques indicate that a large amount of the fuel sulfur is not detected as  $\text{SO}_2$ , then efforts are needed to improve techniques for  $\text{SO}_3$  measurements. Additional work will be required to account for the fuel sulfur in the engine exhaust. Chemical Ionization Mass Spectrometry (CI-MS) measurements need to be pursued, although a careful assessment needs to be made of the sampling line impact on the extracted sample composition. Efforts should also be placed on implementing non-intrusive techniques and extending their capabilities by maximizing exhaust coverage for line-of-sight measurements, as well as development of 2-D techniques, where feasible. Recommendations were made to continue engine exit and combustor measurements of particulates. Particulate measurements should include particle size distribution, mass fraction, hydration properties, and volatile fraction. However, methods to ensure that unaltered samples are obtained need to be developed. Particulate speciation was also assigned a high priority for quantifying the fractions of carbon soot, PAH, refractory materials, metals, sulfates, and nitrates. High priority was also placed on performing a comparison of particle sizing instruments. Concern was expressed by the workshop attendees who routinely make particulate measurements about the variation in number density measured during in-flight tests by different instruments. In some cases, measurements performed by different groups of researchers during the same flight tests showed an order of magnitude variation.

Second priority was assigned to measuring concentrations of odd hydrogen and oxidizing species. Since OH, HO<sub>2</sub>, H<sub>2</sub>O<sub>2</sub>, and O are extremely reactive, non-extractive measurements are recommended. A combination of absorption and fluorescence is anticipated to be effective for OH measurements in the combustor and at the engine exit. Extractive measurements of HO<sub>2</sub> have been made in the stratosphere, where the ambient level of OH is relatively low. Use of techniques that convert HO<sub>2</sub> to OH for combustor and engine exit measurements needs to be evaluated, since the ratio of HO<sub>2</sub>/OH may be 1% or less at both the combustor and engine exit. CI-MS might be a viable option for H<sub>2</sub>O<sub>2</sub>, subject to sampling line conversion issues. However, H<sub>2</sub>O<sub>2</sub> is a low priority oxidizing species in the combustor and at the engine exit. Two candidates for atomic oxygen measurements are Resonance Enhanced Multi-Photon Ionization (REMPI) and Laser-Induced Fluorescence (LIF). Particulate measurement by simultaneous extractive and non-extractive techniques was given equal priority to the oxidizer measurements. Concern was expressed over the ability of typical ground test sampling lines to deliver an unaltered sample to a remotely located instrument. It was suggested that the sampling probe and line losses be checked out by attempting measurements using an optical or non-extractive technique immediately upstream of the sampling probe. This is a possible application for Laser Induced Incandescence (LII) as a check on the volume fraction of soot. Optical measurements of size distribution are not well developed for ultrafine particles less than about 20 nm in diameter, so a non-extractive technique for particulate size distribution cannot be recommended without further development. Carbon dioxide measurements need to be made to complement other extractive measurement techniques. CO<sub>2</sub> measurements enable conversion of other species concentrations to emission indices. Carbon monoxide, which acts as a sink for oxidizing species, should be measured using non-extractive techniques. CO can be rapidly converted to CO<sub>2</sub> in extractive probes, and a comparison between extractive and non-extractive measurements should be performed. Development of non-extractive techniques would help to assess the degree of CO conversion, and might be needed to improve the concentration measurement accuracy. Measurements of NO(x) will continue to be critical due to the role of NO and NO<sub>2</sub> in atmospheric chemistry, and their influence on atmospheric ozone. Time-resolved measurements of temperature, velocity, and species concentrations were included on the list of desired measurement. Thermocouples are typically adequate for engine exit measurements. PIV and LDV are well established for obtaining velocity profiles. The techniques are listed in the accompanying table; are divided into extractive and non-extractive techniques. Efforts were made to include a measurement uncertainty for each technique. An assessment of the technology readiness was included.

**Author**

*Aerosols; Exhaust Gases; Nonintrusive Measurement; Optical Measurement; Particulates; Plumes; Technology Assessment; Turbine Engines; Measuring Instruments*

19990089316 Kyushu Univ., Graduate School of Engineering, Fukuoka, Japan

Design and Basic Considerations of Contra-Rotating Axial Flow Pump

Furukawa, Akinori, Kyushu Univ., Japan; Cao, Yinchun, Kyushu Univ., Japan; Watanabe, Satoshi, Kyushu Univ., Japan; Technology Reports of Kyushu University; May 1999; Volume 72, No. 3, pp. 207-214; In Japanese; See also 19990089315; No Copyright; Avail: CASI; A02, Hardcopy; A02, Microfiche

Contra-rotating axial flow rotors, which have been used as a ship propeller and a fan, might be prospective as a pump if higher performance and wider operation range would be obtained than the conventional type of axial flow pumps. At the first stage before starting the experimental work, the selection of design specific speed is discussed for a contra-rotating pump and the pump is designed by using a conventional method based on experimental data for linear cascade. Then the performance and operable range of the contra-rotating linear cascades, having the same blade arrangement as that at the blade tip radius of the test rotors, are estimated with one dimensional calculation and empirical formulas. The results are compared with those of a conventional pump with rotor and stator in order to clarify the merit of this type of pump.

**Author**

*Axial Flow Pumps; Rotors; Design Analysis*

19990103594 NASA Goddard Space Flight Center, Greenbelt, MD USA

Flight Performance of the Balloon Gondola Solar Pointing System

Simpson, Joel, NASA Goddard Space Flight Center, USA; Hall, Kenneth, NASA Goddard Space Flight Center, USA; 1999; 1p; In English; 13th International Balloon Technology, 28 Jun. - 1 Jul. 1999, Norfolk, VA, USA; Sponsored by American Inst. of Aeronautics and Astronautics; No Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

The NASA Solar Pointing System (SPS) has made two operational flights since its test flight in April of 1997. This pointing device was conceived and designed to provide ultra-low power gondola pointing primarily for directing gondola-fixed solar panels toward the sun. While typically consuming less than 5 watts, the system is capable of suspending and pointing up to 3400 kg. The SPS has logged over 25 days of mostly continuous operation. The performance data, including power consumption and

pointing accuracy for these two successful flights is presented and analyzed. The data is compared to predictions and test flight data. Suggestions for further developments and applications including Ultra-Long Duration Balloon (ULDB) are discussed.

Author

*Balloon-Borne Instruments; Gondolas; Pointing Control Systems; Flight Control*

## 13 GEOSCIENCES

*Includes geosciences (general); earth resources and remote sensing; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.*

19990094050 NASA Goddard Space Flight Center, Greenbelt, MD USA

Satellite Altimeter Observations of Black Sea Level Variations

Korotaev, G. K., Marine Hydrophysical Inst., USSR; Saenko, O. A., Marine Hydrophysical Inst., USSR; Koblinsky, C. J., NASA Goddard Space Flight Center, USA; 1998; 37p; In English; Copyright; Avail: Issuing Activity, Hardcopy

Satellite altimeter data from TOPEX/POSEIDON and ERS-1 are used to examine seasonal and mesoscale variability of the Black Sea level. Consistent processing procedures of the altimeter measurements make it possible to determine the dynamical Black Sea level with an rms accuracy about 3 cm. It is shown that the Black Sea circulation intensifies in the winter-spring seasons and attenuates in summer-autumn. The seasonal variability of sea level is accompanied by a radiation of Rossby waves from the eastern coast of the basin. Mesoscale oscillations of the dynamical sea level are found to vary spatially and temporally. Usually, strong eddy intensity is associated with instabilities of the Rim Current. Away from this circulation feature, in the deep basin, mesoscale variability is much smaller. Mesoscale variability has a strong seasonal signal, which is out of phase with the strength of the Rim Current.

Author

*Altimeters; Black Sea; Sea Level; Satellite Observation; Annual Variations*

19990105640 Houston Univ., TX USA

Conceptual Design of a Martian Power Generating System Utilizing Solar and Wind Energy

Second Annual HEDS-UP Forum; 1999, pp. 131-145; In English; See also 19990105633; Copyright; Avail: Issuing Activity, Hardcopy

An all-solar manned mission to Mars must overdesign the photovoltaic array in order to handle dust storm conditions. Wind energy extraction is proven terrestrial technology which can offset the dust storm (and night-time) reductions. A multi-phase project is underway to assess the feasibility and drive the development of wind energy extraction systems for Mars. This project has specifically addressed the design of a Darrieus-style Vertical Axis Wind Turbine (VAWT). The project assumed that wind energy extraction would be a secondary production system to the photovoltaic array. Energy production of 300 kw-hr per Martian day is required for this application. The wind turbine is designed by iteratively stepping through the following tasks: 1. Choose a blade shape; 2. Calculate the aerodynamic loads (primarily to estimate performance); 3. Design the guy cables; 4. Design the blades; 5. Design the tower; and 6. Choose support equipment. The resulting system was estimated at 944 kg. Based on the feasibility assessment mentioned above, a wind speed of 28 m/s or higher must be seen for at least an hour each day. This wind speed is in the realm of possibility as the expected slope winds on Mars will likely be this high or higher. In order to meet this feasibility, the following design trends were seen: low pre-tension guy wires; ultralight blades, and thin lightweight towers. This work also found that if 25 to 35 m/s winds are available for at least one hour during a Martian day (during a dust storm), then wind energy extraction can be expected to be at least as mass-efficient as solar arrays (during a dust storm). Significant issues such as structural dynamics, thermal expansion/contraction, fatigue, blade struts, deployability, and maintainability were not considered at this time.

Author

*Aerodynamic Loads; Dynamic Structural Analysis; Estimating; Feasibility Analysis; Manned Mars Missions; Electric Generators*

19990090016 NASA Goddard Space Flight Center, Greenbelt, MD USA

Assessment of the Effects of High-Speed Aircraft in the Stratosphere; 1998

Kawa, S. Randolph, NASA Goddard Space Flight Center, USA; Anderson, James G., Harvard Univ., USA; Baumgardt, Steven L., Boeing Co., USA; Brock, Charles A., Denver Univ., USA; Brune, William H., Pennsylvania State Univ., USA; Cohen, Ronald C., California Univ., USA; Kinnison, Douglas E., National Center for Atmospheric Research, USA; Newman, Paul A., NASA

Goddard Space Flight Center, USA; Rodriguez, Jose M., Miami Univ., USA; Stolarski, Richard S., NASA Goddard Space Flight Center, USA; Waugh, Darryn, Johns Hopkins Univ., USA; June 1999; 22p; In English  
Report No.(s): NASA/TP-1999-209237; NAS 1.60:209237; Rept-99B00055; No Copyright; Avail: CASI; A11, Hardcopy; A03, Microfiche

This report assesses the potential atmospheric impacts of a proposed fleet of high-speed civil transport (HSCT) aircraft. The purpose of the report is to assess the effects of HSCT's on atmospheric composition and climate in order to provide a scientific basis for making technical, commercial, and environmental policy decisions regarding the HSCT fleet. The work summarized here was carried out as part of NASA's Atmospheric Effects of Aviation Project (a component of the High-Speed Research Program) as well as other NASA, U.S., and international research programs. The principal focus is on change in stratospheric ozone concentrations. The impact on climate change is also a concern. The report describes progress in understanding atmospheric processes, the current state of understanding of HSCT emissions, numerical model predictions of HSCT impacts, the principal uncertainties in atmospheric predictions, and the associated sensitivities in predicted effects of HSCT's.

Author

*Environment Effects; Transport Aircraft; Stratosphere; Climate Change; Supersonic Transports; Ozone*

19990099371 MVA Ltd, London, UK

A Policy-Sensitive Forecasting System for Evaluating the Economic and Environmental Effects of Measures to Reduce Aircraft Emissions

Lowe, Steve, MVA Ltd, UK; Baarse, Gerrit, Resource Analysis, Netherlands; vanVelzen, Andre, Resource Analysis, Netherlands; tenHave, Helmut, National Aerospace Lab., Netherlands; Pulles, Hans, Rijksluchtvaartdienst, Netherlands; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 22p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Continuing growth in civil aviation activity may be having adverse impacts on global warming and UV radiation due to aircraft emissions in the upper atmosphere. Recognising this, but that mitigating measures might themselves have adverse economic implications for the aviation industry and national economies, the Dutch government commissioned Project AERO (Aviation Emissions and Evaluation of Reduction Options) to find the "best" strategy to reduce air traffic effects on the atmosphere, by weighing the environmental benefits against the economic consequences. Project AERO has created a forecasting system of future world-wide aviation activity, with its environmental and economic impacts, to test a wide range of fiscal and regulatory measures that might reduce aircraft emissions, and to establish trade-offs between environmental effectiveness and the economic consequences for airlines, users and governments. The system's forecasts are largely driven by demand growth, but costs imposed on airline operation by policy measures are modelled to feed back to fares, and hence restraint of demand growth, capacity provided and airline profitability. Aircraft technology development is explicitly represented, and emission volumes, their spatial distribution and atmospheric impacts are also modelled. The paper describes the AERO system and presents preliminary results of policy tests.

Author

*Commercial Aircraft; Economic Impact; Environment Effects; Forecasting; Test Ranges; Evaluation; Exhaust Emission; Spacecraft Glow*

19990099372 Tamkang Univ., Taipei, Taiwan, Province of China

Modeling Airline Competition With Two Fare Classes Under Static and Dynamic Games

Shyr, Feng-Yeu, Tamkang Univ., Taiwan, Province of China; Li, Chung-Pin, Tamkang Univ., Taiwan, Province of China; The Conference Proceedings of the 1998 Air Transport Research Group (ATRG) of the WCTR Society; December 1998; Volume 4; 16p; In English; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Since the regulations on air fares, flight frequency, and the number of airlines for each O-D market have been removed in the last decade, Taiwan's domestic air travel market has now become one of the most competitive market in Southeast Asia. In order to assess the impact of deregulation, this paper applies game theory to seek for the strategic interaction among airlines in the oligopolistic competition environment. The strategies related to pricing include discount prices, service upgrade, and frequent flyer programs; for those related to quality of service include foods, comfort of seating, entertaining programs, reliability of schedule, baggage handling, and the frequency of direct and transfer flights. This paper focuses on the price and frequency competition of domestic airlines. Meanwhile, since the flight distances of all Taiwan's domestic routes are less than 500 miles, therefore, this paper emphasizes on direct flights only. The objectives of this paper are as follow: 1) develop a mathematical model

that interpret and predict the interaction among airlines in the competition market; 2) provide a guideline for airlines in the decision of prices and frequency of flights; and 3) present an analytical tool for policy makers in the impact assessment of deregulation.

**Author**

*Regulations; Policies; Mathematical Models; Game Theory; Competition; Commercial Aircraft; Civil Aviation; Airline Operations*

**19990102951 NASA Glenn Research Center, Cleveland, OH USA**

Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines

Wey, Chown Chou, Compiler, NASA Glenn Research Center, USA; June 1999; 254p; In English, 29-30 Jul. 1997, Cleveland, OH, USA; See also 19990102952 through 19990102964

Contracts/Grants: RTOP 538-08-12

Report No.(s): NASA/CP-1999-208918; E-11676; NAS 1.55-208918; No Copyright; Avail: CASI; A12, Hardcopy; A03, Microfiche

In response to the National Research Council (NRC) recommendations, the Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines was organized by the NASA Lewis Research Center and held on July 29-30, 1997 at the Ohio Aerospace Institute in Cleveland, Ohio. The objective is to develop consensus among experts in the field of aerosols from gas turbine combustors and engines as to important issues and venues to be considered. Workshop participants' expertise included engine and aircraft design, combustion processes and kinetics, atmospheric science, fuels, and flight operations and instrumentation.

**Author**

*Aerosols; Gas Turbine Engines; Particulates; Conferences; Exhaust Gases; Combustion Products*

**19990102952 NASA Glenn Research Center, Cleveland, OH USA**

Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines

Niedzwiecki, Richard, NASA Glenn Research Center, USA; Dryer, Frederick L., Princeton Univ., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 5-19; In English; See also 19990102951; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This paper reviews the relationships of the programs and projects and reviews the purpose of the Engine Exhaust Trace Chemistry (EETC) Committee. The charges of the Committee are: (1) to prioritize the engine trace constituents for assessing impacts of aircraft; (2) Assess both extractive and insitu measurement techniques; and (3) Determine the best venues for performing the necessary measurements. A synopsis of evidence supporting and questions concerning the role(s) of aerosol/particulates was presented. The presentation also reviewed how sulfur oxidation kinetics interactions in the hot-section and nozzle play a role in the formation of aerosol precursors. The objective of the workshop, and its organization is reviewed.

Derived from text

*Aircraft Engines; Gas Turbine Engines; Air Pollution; Particulates; Trace Elements; Aerosols*

**19990102953 NASA Glenn Research Center, Cleveland, OH USA**

Problem to Address: Local Air Quality

Niedzwiecki, Richard W., NASA Glenn Research Center, USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 21-44; In English; See also 19990102951; No Copyright; Avail: CASI; A03, Hardcopy; A03, Microfiche

This presentation discusses the problem of local air quality as it is affected by modern aircraft engine exhaust and the objective of this workshop. It begins with a discussion on the nature and sources of particulates and aerosols. The problems, and the technical considerations of how to regulate the aircraft emissions, are reviewed. There is no local (i.e., state or county) regulations of the aircraft operations. Amongst the conclusions are: (1) there is an inadequate database of information regarding the emittants from aircrafts; (2) That data which does exist represents older engines and aircraft, it is not representative of the advanced and future fleet.

CAS<sup>1</sup>

*Air Quality; Aircraft Engines; Flight Operations; Regulations; Pollution Control; Pollution Monitoring; Air Pollution*

**19990102954 Aerodyne Research, Inc., Billerica, MA USA**

Statement of Problem: Engine and Near-Field; Aerosol and Particulate

Miake-Lye, R. C., Aerodyne Research, Inc., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 45-54; In English; See also 19990102951; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The primary objective of NASA's Atmospheric Effects of Aviation Project (AEAP) is to assess the global impact of emissions deposited in the atmosphere from commercial aviation operating at cruise altitudes. Historically, the global implications of aircraft emissions have not been the subject of legislative regulation as have near-airport impacts, so the measurements to quantify these high altitude emissions are not a standard part of engine certification and are generally not available. Thus, a significant component of AEAP is to characterize the cruise emissions from the commercial fleet. In the first years of AEAP, planning and prioritizing of the species and measurement techniques were carried out to establish the direction of the emissions characterization element of AEAP. The current status of the activity to date is that CO<sub>2</sub>, H<sub>2</sub>O, and NO(x), have been well characterized. These primary combustion products and the pollutant emissions that have been the focus of many global studies to date have been measured with multiple techniques and at multiple venues, including in-flight. In addition to these gaseous emissions, non-volatile (soot) particle number densities and particle size data are now available for many engines and multiple measurement venues, as well. From these efforts, primary emissions can be quantified with reasonable accuracy for the existing commercial fleet and projections for these emissions can be made for future technologies. On the other hand, modeling and in-flight measurements have raised questions about other emissions which have yet to be fully characterized. For NO(x) emissions, the conversion to non-NO(x) NO(y) (HONO, HNO<sub>3</sub>) has not been quantified. Based on chemical kinetics calculations, this conversion is expected to be modest and global modeling results suggest that, for such modest conversions, the global effects are predicted to be small. A more uncertain situation holds for sulfur emissions. The degree of SO<sub>2</sub> oxidation to SO<sub>3</sub> and H<sub>2</sub>SO<sub>4</sub> also has not been quantified for many situations and has implications for aerosol formation as discussed. Further, the state of emitted aerosols needs characterization beyond the number densities and size distributions to understand how emitted aerosol may affect contrail and cloud formation. More specifically, when, where, and how does soot become condensation nuclei (CN) capable of condensing water vapor? In order to fully understand how these questions affect the global atmosphere, chemical and physical processes that are occurring in the near-field of the airplane's wake and, indeed, with in the engine itself need to be understood.

**Author**

*Airline Operations; Atmospheric Effects; Combustion Products; Commercial Aircraft; Contaminants; Exhaust Emission; Air Pollution; Aircraft Engines*

19990102955 NASA Goddard Space Flight Center, Greenbelt, MD USA

Potential Climate Impacts of Engine Particle Emissions

Kawa, S. Randy, NASA Goddard Space Flight Center, USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 55-60; In English; See also 19990102951; No Copyright; Avail. CASE; A02, Hardecopy; A03, Microfiche

Solid (soot) and liquid (presumed sulfate) particle emissions from aircraft engines may have serious impacts on the atmosphere. While the direct radiative impact of these particles is expected to be small relative to those from natural sources (Atmospheric Effects of Subsonic Aircraft: Interim Assessment of the Advanced Subsonic Technology Program, NASA Ref. Pub. 1400, 1997), their indirect effects on atmospheric chemistry and cloud formation may have a significant impact. The potential impacts of primary concern are the increase of sulfate surface area and accelerated heterogeneous chemical reactions, and the potential for either modified soot or sulfate particles to serve as cloud nuclei which would change the frequency or radiative characteristics of clouds. Volatile (sulfate) particle concentrations measured behind the Concorde aircraft in flight in the stratosphere were much higher than expected from near-field model calculations of particle formation and growth. Global model calculations constrained by these data calculate a greater level of stratospheric ozone depletion from the proposed High speed Civil Transport (HSCT) fleet than those without particle emission. Soot particles have also been proposed as important in heterogeneous chemistry but this remains to be substantiated. Aircraft volatile particle production in the troposphere has been shown by measurements to depend strongly on fuel sulfur content. Sulfate particles of sufficient size are known to provide a good nucleating surface for cloud growth. Although pure carbon soot is hydrophobic, the solid particle surface may incorporate more suitable nucleating sites. The non-volatile (soot) particles also tend to occupy the large end of aircraft particle size spectra. Quantitative connection between aircraft particle emissions and cloud modification has not been established yet, however, even small changes in cloud amount or properties could have a significant effect on the radiative balance of the atmosphere.

**Author**

*Atmospheric Chemistry; Exhaust Emission; Exhaust Gases; Particle Emission; Soot; Supersonic Transports; Troposphere; Climate; Long Term Effects; Climate Change*

19990102956 Missouri Univ., Rolla, MO USA

UMR Mobile Aerosol Sampling Facility and Smoke Meter

Hagen, D. E., Missouri Univ., USA; Whitefield, P. D., Missouri Univ., USA; Paladino, J., Missouri Univ., USA; Lilientfeld, H. V., Missouri Univ., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 61-82; In English; See also 19990102951; No Copyright; Avail. CASE; A03, Hardecopy; A03, Microfiche

This presentation discusses the mobile aerosol sampling facility and the smoke meter developed at the University of Missouri-Rolla. The aerosol sampling facility device is designed to measure particulates within certain conditions. The properties of the particulates and the test conditions were discussed. Recent airborne sampling and ground test sampling campaigns are reviewed. A diagram of the mobile aerosol sampling system and several charts showing the aerosol size distribution are shown. The presentation then reviews the smoke meter, which attempts to measure the particulate emission in the jet engine exhaust flow. Several known volumes of exhaust are passed through a filter, and any change in the observed optical reflectance of the filter can be correlated to the quantity of particulate matter. The recent studies which used the smoke meter are reviewed.

CASI

*Air Sampling; Jet Engines; Samplers; Sampling; Smoke; Aircraft Engines; Aerosols; Exhaust Emission; Particle Emission*

19900102957 NASA Langley Research Center, Hampton, VA USA

Airborne Observations of Aerosol Emissions from F-16 Aircraft

Anderson, B. E., NASA Langley Research Center, USA; Cofer, W. R., NASA Langley Research Center, USA; McDougal, D. S., NASA Langley Research Center, USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1990, pp. 83-100; In English; See also 19900102951; No Copyright; Avail. CASI: A03, Hardcopy, A03, Microfiche

We presented results from the SASS Near-Field Interactions Flight (SNIF-III) Experiment which was conducted during May and June 1997 in collaboration with the Vermont and New Jersey Air National Guard Units. The project objectives were to quantify the fraction of fuel sulfur converted to S(VI) species by jet engines and to gain a better understanding of particle formation and growth processes within aircraft wakes. Size and volatility segregated aerosol measurements along with sulfur species measurements were recorded in the exhaust of F-16 aircraft equipped with F-100 engines burning fuels with a range of fuel S concentrations at different altitudes and engine power settings. A total of 10 missions were flown in which F-16 exhaust plumes were sampled by an instrumented T-39 Sabreliner aircraft. On six of the flights, measurements were obtained behind the same two aircraft, one burning standard JP-8 fuel and the other either approximately 28 ppm or 1100 ppm S fuel or an equal mixture of the two (approximately 560 ppm S). A pair of flights was conducted for each fuel mixture, one at 30,000 ft altitude and the other starting at 35,000 ft and climbing to higher altitudes if contrail conditions were not encountered at the initial flight level. In each flight, the F-16s were operated at two power settings, approx. 80% and full military power. Exhaust emissions were sampled behind both aircraft at each flight level, power setting, and fuel S concentration at an initial aircraft separation of 30 m, gradually widening to about 3 km. Analyses of the aerosol data in the cases where fuel S was varied suggest results were consistent with observations from project SUCCESS, i.e., a significant fraction of the fuel S was oxidized to form S(VI) species and volatile particle emission indices (EIs) in comparably aged plume, exhibited a nonlinear dependence upon the fuel S concentration. For the high sulfur fuel, volatile particle EIs in 10-second-old-plumes were  $2 \text{ to } 3 \times 10^{17} / \text{kg}$  of fuel burned and exhibited no obvious trend with engine power setting or flight altitude. In contrast, about 8-fold fewer particles were observed in similarly aged plumes from the same aircraft burning fuel with 560 ppm S content and EIs of  $1 \times 10^{15} / \text{kg}$  of fuel burned were observed in the 28 ppm S fuel case. Moreover, data recorded as a function of plume age indicates that formation and growth of the volatile particles proceeds more slowly as the fuel S level is reduced. For example, ultrafine particle concentrations appear to stabilize within 5 seconds after emission in the 1100 ppm S cases but are still increasing in 20-second old plumes produced from burning the 560 ppm S fuel.

Author

*Aerosols; Aircraft Wakes; Exhaust Emission; Exhaust Gases; Particle Emission; Plumes; Jet Engine Fuels; Sulfur*

19900102958 McDonnell-Douglas Corp., Saint Louis, MO USA

Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines

Lilientfeld, Harvey V., McDonnell-Douglas Corp., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1990, pp. 101-121; In English; See also 19900102951; No Copyright; Avail. CASI: A03, Hardcopy, A03, Microfiche

Prior to 1990, the major source of measurements on particulate emissions from aircraft utilized the measurement of 'smoke numbers'. This technique was developed to quantify the light scattering properties of engine exhaust, but is not directly applicable for modeling of the effects of engine particulates on the atmosphere. The data base for particulate emissions from aircraft flying in the atmosphere has increased dramatically in the last few years due to the implementation of equipment capable of measuring particle number densities, size distributions, hydration properties and emission indices. This equipment was developed to quantify engine exhaust emissions because of concerns of the environmental impact of supersonic and subsonic aircraft. This paper reports on the status of the data base obtained from these measurements and reports on the correlations currently being used to characterize the current and future fleets of aircraft flying in the troposphere and stratosphere. As a result of project Pollnet, a European campaign to measure the effects of emissions of subsonic aircraft, a number of particle emission indices were measured by workers

from the University of Missouri Rolla and their associates. These results for particle emission indices (particles/kg fuel burned) for both total particles and non-volatile particles (particles remaining after volatile particles are removed by heating to 170°C) are correlated for a number of aircraft/engine combinations flight at 30000 ft. The agreement among engine types for non-volatile particles (assumed to be predominantly soot) is generally good (within 20%) with a range among the aircraft intercepts of  $2 \times 10^{14}$  -  $2 \times 10^{15}$  particles/Kg fuel. These data were also correlated with smoke numbers obtained from the ICAO data base. Work-in-progress data base correlations are described for an assortment size distributions obtained from measurements on the ground, in the air and in altitude chambers taken during the NASA sponsored projects SNIF and SUCCESS. Interesting measurements of a NASA owned 737 aircraft with JT8 engines and a 757 aircraft with RB-211-535C engines are described. The 757 aircraft is of interest because of the difference seen for particles emissions between the port and starboard engines. This case is interesting because it is very atypical for results to vary this much between engines of the same type. Measurement of emission indices on the ground and in the air for the 757 aircraft are compared. In addition, measurements of this aircraft by several groups are compared. Measurements taken on the ground and in flight for military aircraft flying with F100 engines are compared. The older version of the F100 engine (F100-100 series) appears to have a greater emission than the later F100-200 model at high thrust settings. The emission from both of these older engines is more than an order of magnitude greater than the emissions from a modern engine. These results indicate the improvements made by industry of the past several decades on particulate emissions. The size distributions of particles emitted from these aircraft appear to change somewhat as a function of thrust setting. Size distributions among the engine models F100-100 vs F100-200 are compared but the differences noted may represent different operating conditions as well as differences among engine models.

Author

*Aerosols; Aircraft Engines; Exhaust Emission; Exhaust Gases; Gas Turbine Engines; Particle Emission; Jet Engines; Jet Exhaust*

[19990102959] NASA Glenn Research Center, Cleveland, OH USA

Engine Test and Measurements

Wey, Chawn Chou, NASA Glenn Research Center, USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines, June 1999, pp. 123-134; In English; See also 19990102951; No Copyright; Avail: CASE: A03, Hardcopy; A03, Microfiche

Although the importance of aerosols and their precursors are now well recognized, the characterization of current subsonic engines for these emissions is far from complete. Furthermore, since the relationship of engine operating parameters to aerosol emissions is not known, extrapolation to untested and unbuilt engines necessarily remains highly uncertain. 1997 NASA LaRC engine test, as well as the parallel 1997 NASA LaRC flight measurement, attempts to address both issues by expanding measurements of aerosols and aerosol precursors with fuels containing different levels of fuel sulfur content. The specific objective of the 1997 engine test is to obtain a database of sulfur oxides emissions as well as the non-volatile particulate emission properties as a function of fuel sulfur and engine operating conditions. Four diagnostic systems, extractive and non-intrusive (optical), will be assembled for the gaseous and particulate emissions characterization measurements study. NASA is responsible for the extractive gaseous emissions measurement system which contains an array of analyzers dedicated to examining the concentrations of specific gases (NO, NO<sub>x</sub>, CO, CO<sub>2</sub>, O<sub>2</sub>, THC, SO<sub>2</sub>) and the smoke number. University of Missouri-Rolla uses the Mobile Aerosol Sampling System to measure aerosol/particulate total concentration, size distribution, volatility and hydration property. Air Force Research Laboratory uses the Chemical Ionization Mass Spectrometer to measure SO<sub>2</sub>, SO<sub>3</sub>/H<sub>2</sub>SO<sub>4</sub>, and HNO<sub>3</sub>. Aerodyne Research, Inc. uses Infrared Tunable Diode Laser system to measure SO<sub>2</sub>, SO<sub>3</sub>, NO, H<sub>2</sub>O, and CO<sub>2</sub>.

Author

*Engine Tests; Gas Composition; Particulates; Jet Engines; Jet Exhaust*

[19990102960] Massachusetts Inst. of Tech., Aero-Environmental Research Lab., Cambridge, MA USA

Hot Section Modeling

Waitz, Ian A., Massachusetts Inst. of Tech., USA; Lukachko, S. P., Massachusetts Inst. of Tech., USA; Miao-Lye, Richard C., Aerodyne Research, Inc., USA; Brown, Robert C., Aerodyne Research, Inc., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines, June 1999, pp. 135-142; In English; See also 19990102951; No Copyright; Avail: CASE: A03, Hardcopy; A03, Microfiche

Many aircraft engine exhaust species that may perturb the atmosphere exist in trace amounts. These species can be transformed by chemical reaction within the engine prior to emission into the atmosphere. To better understand the role of intra-engine processes in determining the final composition of engine exhaust, a flow-chemistry model was developed over the last three years through a collaboration between the Massachusetts Institute of Technology (MIT) and Aerodyne Research, Inc. (ARI). This computational approach was used to investigate chemical processes that occur through the turbine and exhaust nozzle

by simulating the post-combustor flow path over a range of physical representations, from simplified, homogeneous cases to situations that incorporate complex fluid mechanics more typical of a modern aircraft turbine. Using a chemistry model that includes  $\text{HO}(x)$ ,  $\text{NO}(y)$ ,  $\text{SO}(x)$ , and  $\text{CO}(x)$ , reactions developed through the work of Robert C. Brown of ARI and Fred L. Dryer of Princeton University, several 1-D parametric analyses were conducted for the entire turbine and exhaust nozzle flowpath of a typical advanced subsonic engine to understand the effects of important flow and chemistry variations on species evolution in general, and the development of volatile aerosol precursors in particular. These studies highlighted the sensitivity of exhaust composition to the trace species concentrations specified at the combustor exit, mass addition within the turbine, and combustor exit temperature. Representative 2-D, single turbine blade row simulations were also performed to determine the potential impact of flow nonuniformities that cannot be captured directly or modeled simply through 1-D analyses. Temperature nonuniformities that result from the use of an internal blade cooling strategy were investigated and revealed a significant impact in  $\text{SO}(x)$  chemistry. Comparisons of 1-D approximations to the 2-D turbine solutions were then carried out to help determine the extent to which current 1-D modeling capabilities can resolve changes in chemical composition. The results call into question the validity of 1-D averaged flow analysis for the highly-nominal, unsteady flow fields of the turbine and exhaust nozzle. Suggestions for future work under the AEAP program are included.

#### Author

*Aircraft Engines; Gas Turbine Engines; Simulation; Models; Turbine Exhaust Nozzles*

19990102962 NASA Glenn Research Center, Cleveland, OH USA

Trace Chemistry

**Radhakrishnan, Krishnam**, NASA Glenn Research Center, USA; **Whitfield, Philip**, Missouri Univ., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 177-178; In English; See also 19990102951; No Copyright; Avail. CASI; A01, Hardcopy; A03, Microfiche

The goals of the trace chemistry group were to identify the processes relevant to aerosol and aerosol precursor formation occurring within aircraft gas turbine engines, that is, within the combustor, turbine, and nozzle. The topics of discussion focused on whether the chemistry of aerosol formation is homogeneous or heterogeneous; what species are important for aerosol and aerosol precursor formation; what modeling/theoretical activities to pursue; what experiments to carry out that both support modeling activities and elucidate fundamental processes; and the role of particulates in aerosol and aerosol precursor formation. The consensus of the group was that attention should be focused on  $\text{SO}_2$ ,  $\text{SO}_3$ , and aerosols. of immediate concern is the measurement of the concentration of the species  $\text{SO}_3$ ,  $\text{SO}_2$ ,  $\text{H}_2\text{SO}_4$ ,  $\text{OH}$ ,  $\text{HO}_2$ ,  $\text{H}_2\text{O}_2$ ,  $\text{O}$ ,  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{HONO}$ ,  $\text{HNO}_3$ ,  $\text{CO}$ , and  $\text{CO}_2$  and particulates in various engines, both those currently in use and those in development. The recommendation is that concentration measurements should be made at both the combustor exit and the engine exit. At each location the above species were classified into one of four categories of decreasing importance, Priority I through IV, as follows: Combustor exit: Priority I species -  $\text{SO}_3:\text{SO}_2$  ratio,  $\text{SO}_3$ ,  $\text{SO}_2$ , and particulates; Priority II species:  $\text{OH}$  and  $\text{O}$ ; Priority III species -  $\text{NO}$  and  $\text{NO}_2$ ; and Priority IV species -  $\text{CO}$  and  $\text{CO}_2$ . For the Engine exit: Priority I species -  $\text{SO}_3:\text{SO}_2$  ratio,  $\text{SO}_3$ ,  $\text{SO}_2,\text{H}_2\text{SO}_4$ , and particulates; Priority II species:  $\text{OH},\text{HO}_2$ ,  $\text{H}_2\text{O}_2$ , and  $\text{O}$ ; Priority III species -  $\text{NO}$ ,  $\text{NO}_2$ ,  $\text{HONO}$ , and  $\text{HNO}_3$ ; and Priority IV species -  $\text{CO}$  and  $\text{CO}_2$ . Table I summarizes the anticipated concentration range of each of these species. For particulate matter, the quantities of interest are the number density, size distribution, and composition. In order to provide data for validating multidimensional reacting flow models, it would be desirable to make 2-D, time-resolved measurements of the concentrations of the above species and, in addition, of the pressure, temperature, and velocity. A near term goal of the experimental program should be to confirm the nonlinear effects of sulfur speciation, and if present, to provide an explanation for them. It is also desirable to examine if the particulate matter retains any sulfur. The recommendation is to examine the effects on  $\text{SO}_x$  production of variations in fuel-bound sulfur and aromatic content (which may affect the amount of particulates formed). These experiments should help us to understand if there is a coupling between particulate formation and  $\text{SO}_x$  concentration. Similarly, any coupling with  $\text{NO}_x$  can be examined either by introducing  $\text{NO}_x$  into the combustion air or by using fuel-bound nitrogen. Also of immediate urgency is the need to establish and validate a detailed mechanism for sulfur oxidation/aerosol formation, whose chemistry is concluded to be homogeneous, because there is not enough surface area for heterogeneous effects. It is envisaged that this work will involve both experimental and theoretical programs. The experimental work will require, in addition to the measurements described above, fundamental studies in devices such as flow reactors and shock tubes. Complementing this effort should be modeling and theoretical activities. One impediment to the successful modeling of sulfur oxidation is the lack of reliable data for thermodynamic and transport properties for several species, such as aqueous nitric acid, sulfur oxides, and sulfuric acid. Quantum mechanical calculations are recommended as a convenient means of deriving values for these properties. Such calculations would also help establish rate constants for several important reactions for which experimental measurements are inherently fraught with uncertainty. Efforts to implement sufficiently detailed chemistry into computational fluid dynamic codes should be continued.

Zero- and one-dimensional flow models are also useful vehicles for elucidating the minimal set of species and reactions that must be included in two- and three-dimensional modeling studies.

#### Author

*Aerosols; Aircraft Engines; Combustion Chambers; Concentration (Composition); Gas Turbine Engines; Mathematical Models; Oxidation; Particulates; Reaction Kinetics; Trace Contaminants*

19990102964 NASA Glenn Research Center, Cleveland, OH USA

Aerosols and Particulates Workshop Sampling Procedures and Venues Working Group Summary

Pachlhofer, Peter, NASA Glenn Research Center, USA; Howard, Robert, Sverdrup Technology, Inc., USA; Workshop on Aerosols and Particulates from Aircraft Gas Turbine Engines; June 1999, pp. 187-237; In English; See also 19990102951; No Copyright; Avail: CASI; A04, Hardcopy; A03, Microfiche

The Sampling Procedures and Venues Workgroup discussed the potential venues available and issues associated with obtaining measurements. Some of the issues included Incoming Air Quality, Sampling Locations, Probes and Sample Systems. The following is a summary of the discussion of the issues and venues. The influence of inlet air to the measurement of exhaust species, especially trace chemical species, must be considered. Analysis procedures for current engine exhaust emissions regulatory measurements require adjustments for air inlet humidity. As a matter of course in scientific investigations, it is recommended that "background" measurements for any species, particulate or chemical, be performed during inlet air flow before initiation of combustion, if possible, and during the engine test period as feasible and practical. For current regulatory measurements, this would be equivalent to setting the "zero" level for conventional gas analyzers. As a minimum, it is recommended that measurements of the humidity and particulates in the incoming air be taken at the start and end of each test run. Additional measurement points taken during the run are desirable if they can be practically obtained. It was felt that the presence of trace gases in the incoming air is not a significant problem. However, investigators should consider the ambient levels and influences of local air pollution for species of interest. Desired measurement locations depend upon the investigation requirements. A complete investigation of phenomenology of particulate formation and growth requires measurements at a number of locations both within the engine and in the exhaust field downstream of the nozzle exit plane. Desirable locations for both extractive and in situ measurements include: (1) Combustion Zone (Multiple axial locations); (2) Combustor Exit (Multiple radial locations for annular combustors); (3) Turbine Stage (Inlet and exit of the stage); (4) Exit Nozzle (Multiple axial locations downstream of the nozzle). Actual locations with potential for extractive or non-intrusive measurements depend upon the test article and test configuration. Committee members expressed the importance of making investigators aware of various ports that could allow access to various stages of the existing engines. Port locations are engine specific and might allow extractive sampling or innovative hybrid optical-probe access. The turbine stage region was one the most desirable locations for obtaining samples and might be accessed through boroscope ports available in some engine designs. Discussions of probes and sampling systems quickly identified issues dependent on particular measurement quantities. With general consensus, the group recommends SAE procedures for measurements and data analyses of currently regulated exhaust species (CO<sub>2</sub>, CO, THC, NO(x),) using conventional gas sampling techniques. Special procedures following sound scientific practices must be developed as required for species and/or measurement conditions not covered by SAE standards. Several issues arose concerning short lived radicals and highly reactive species. For conventional sampling, there are concerns of perturbing the sample during extraction, line losses, line-wall reactions, and chemical reactions during the sample transport to the analyzers. Sample lines coated with quartz or other materials should be investigated for minimization of such effects. The group advocates the development of innovative probe techniques and non-intrusive optical techniques for measurement of short lived radicals and highly reactive species that cannot be sampled accurately otherwise. Two innovative probe concepts were discussed. One concept uses specially designed probes to transfer optical beams to and from a region of flow inaccessible by traditional ports or windows. The probe can perturb the flow field but must have a negligible impact on the region to be optically sampled. Such probes are referred to as hybrid probes and are under development at AEDC for measurement in the high pressure, high temperature of a combustor under development for power generation. The other concept consists of coupling an instrument directly to the probe. The probe would isolate a representative sample stream, freeze chemical reactions and direct the sample into the analyzer portion of the probe. Thus, the measurement would be performed in situ without sample line losses due either to reactions or binding at the wall surfaces. This concept was used to develop a fast, in situ, time-of-flight mass spectrometer measurement system for temporal quantification of NO in the IMPULSE facility at AEDC. Additional work is required in this area to determine the best probe and sampling technique for each species measurement requirement identified by the Trace Chemistry Working Group. A partial list of Venues was used as a baseline for discussion. Additional venues were added to the list and the list was broken out into the following categories:

(1)Engines (a) Sea Level Test Stands (b) Altitude Chambers; (2) Annular Combustor Test Stands, (3) Sector Flammtube Test Stands, (4) Fundamentals Rigs/Experiments.

Author

*Exhaust Emission; Particulates; Position (Location); Procedures; Sampling; Test Stands; Trace Elements; Jet Engines; Aerosols*

19990089298 NASA Marshall Space Flight Center, Huntsville, AL USA

An Overview of Atmospheric Modeling for Aeronautical and Aerospace Vehicle Simulation Applications

Vaughan, William W., Alabama Univ., USA; Johnson, Dale L., NASA Marshall Space Flight Center, USA; Eberle, L. J., NASA Dryden Flight Research Center, USA; Jun. 08, 1999, 9p; In English; Modeling and Simulation Technologies, 9-11 Aug. 1999, Portland, OR, USA; Sponsored by American Inst. of Aeronautics and Astronautics, USA

Report No./SE: AIAA Paper 99-4188; No Copyright; Avail: Issuing Activity, Hardcopy

An overview is presented of atmospheric modeling relative to aeronautical and aerospace vehicles design, flight simulation, and mission operation applications. Included is a review of the various environmental phenomena and areas of design and mission assessment concern. In particular, the paper discusses the sources of measurements, modeling issues, design application philosophies and examples of models developed for use by the engineering community. This review is based on many years of experience associated with atmospheric model developments and applications to various aeronautical and aerospace programs.

Author

*Atmospheric Models; Aerospace Vehicles; Flight Simulation*

19990099115 NASA Goddard Space Flight Center, Greenbelt, MD USA

Wind Forcing of the North Sea Pole Tide

OConnor, W., NASA Goddard Space Flight Center, USA; Chao, B. F., NASA Goddard Space Flight Center, USA; Zheng, D. W., NASA Goddard Space Flight Center, USA; Au, Z. Y., NASA Goddard Space Flight Center, USA; [1998], 1p; In English, 6-10 Dec. 1998, San Francisco, CA, USA; No Copyright; Avail: Issuing Activity; Abstract Only

The Chandler wobble of the earth's rotation has a period near 14 months and sets up the 0.5 cm amplitude pole tide in the deep oceans. However, the pole tide is anomalously large in the North Sea, where the amplitude increases sharply up to 3 cm along the continental coast. It is shown here that the sea levels are well correlated with winds at the pole tide frequency. The Princeton Ocean Model is used to investigate the response of the North Sea to wind forcing. The barotropic numerical ocean model depicts realistic coastlines and bathymetry at 5 ft x 5 ft resolution, with 97 x 73 grid points. The monthly mean wind fields for the 40-year period (1958-1997) from the National Centers for Atmospheric Prediction (NCEP) reanalysis were used to force the model. The winds were converted to stress with a neutral drag coefficient that varied linearly with windspeed (instead of using the NCEP windstress). A 5-day simulation was made for each month until the resulting flow regime came into equilibrium, and model water levels at various station locations were saved for comparison with tidal-gauge observed sea levels from the Permanent Service for Mean Sea Level (PSMSL). The comparison is made for 10 North Sea stations with high quality tide gauge data. We find: (1) good agreement in annual and semi-annual phases and in the trend of amplitude w.r.t. latitude; (2) more importantly for this study, the model-predicted and observed non-seasonal sea level variations show a very significant temporal correlation as well as spectral coherence. However, a large amplitude difference exists between the two sets -- the overall amplitude variability of the observed is generally a factor of 2-3 larger than the model prediction (this same phenomenon has been reported in ocean circulation studies, although the cause is not yet clear.) Our results indicate that the wind forcing is the main cause of the observed large pole tide in the North Sea.

Author

*Wind Velocity; North Sea; Tides; Aerodynamic Drag; Annual Variations; Mathematical Models; Measuring Instruments; Ocean Currents; Sea Level*

## 14 LIFE SCIENCES

*Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.*

19990092806 Hochschule der Bundeswehr, Inst. for Systemdynamic and Flightmechanic, Munich, Germany

Intelligent Crew Assistant for Military Transport Aircraft

Walsdorf, Anton, Hochschule der Bundeswehr, Germany; Onken, Reiner, Hochschule der Bundeswehr, Germany; Sensor Data Fusion and Integration of the Human Element; February 1999, pp. 1-1 - 1-7; In English; See also 19990092805; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Modern cockpit environments, covering highly integrated and complex automatic functions, pose various demands on the crew. In unusual situations the crew often is overtaxed and acts erroneously. "Clumsy automation" is considered to be a major reason for deficiencies concerning the interaction between cockpit crew and aircraft systems. Cognitive systems appear to be a promising approach to overcome these deficiencies in capabilities in the interpretation and diagnosis of the situation, planning and decision making and the execution of a plan. In this paper a general survey on the principals of cognitive cockpit assistance will be given. Demands and requirements for an appropriate automation and a generic functional structure of a cognitive assistant system will be introduced. A prototype system, the Crew Assistant Military Aircraft (CAMA) its capabilities and function units (modules) are presented and described in detail. In future combat transport aircraft, constraints created by low level flying in a high risk theater, the high rate of change of information and short reaction times required will produce physiological and cognitive problems for pilots. CAMA is designed taking into consideration the approach of human-centered automation.

Author

*Cockpits; Fighter Aircraft; Flight Crews; Transport Aircraft; Decision Support Systems; Pilot Support Systems; Aircraft Equipment*

19990092818 Elektroniksystem- und Logistik G.m.b.H., Experimental Avionics Systems, Munich, Germany

Evaluation of the Cockpit Assistant Military Aircraft CAMA in Simulator Trials

Schulte, Axel, Elektroniksystem- und Logistik G.m.b.H., Germany; Stuetz, Peter, Universitaet der Bundeswehr Muenchen, Germany; Sensor Data Fusion and Integration of the Human Element; February 1999, pp. 16-1 - 16-8; In English; See also 19990092805; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Inappropriate automation is considered to be a major reason for deficiencies on interaction between pilot crew and aircraft systems. The lack of situation awareness is pointed out to be a crucial cause of pilot failure. Because of this, cockpit assistant systems are being developed in support of human-centered automation. CAMA assists military crews during transport missions. This paper consists of three main parts, briefly describing the functional prototype of CAMA, the experimental means taken in order to evaluate the integrated system, and the comprehensive results of two flight simulator campaigns. Firstly, a general survey is given on human factors related problems in this particular domain. Their influence on the principles of cockpit crew assistance will be shown and a brief circumscription of CAMA's main functionalities follows. The description of the simulator facilities for experimentation includes the visual system, the available flight controls and the means for interaction between the pilot and CAMA. The experimental scenario and tasks are pointed out, to get an estimation on the pilot's overall acceptance of the approach and the benefits of the CAMA system, thorough evaluations were conducted.

Author

*Human Factors Engineering; Pilot Support Systems; Avionics; Military Aircraft; Aircraft Equipment; Flight Instruments; Pilot Performance*

19990092824 Air Force Research Lab., Wright-Patterson AFB, OH USA

Integrating Voice Recognition and Automatic Target Cueing to Improve Aircrew-System Collaboration for Air-to-Ground Attack

Barbato, Greg, Air Force Research Lab., USA; Sensor Data Fusion and Integration of the Human Element; February 1999, pp. 24-1 - 24-11; In English; See also 19990092805; Copyright Waived; Avail: CASI; A03, Hardcopy; A03, Microfiche

Automatic target cueing and pilot voice recognition were integrated into a single-seat fighter cockpit simulator and were evaluated. Pilots were required to fly a pre-planned route to an airfield, where the identified and designated for attack, six tanker aircraft from a group of fifteen aircraft that were parked on the airfield. During navigation and weapon delivery segments of the mission simulated Airborne Warning and Control directed the pilots to: (1) modify their flight route, (2) change radio frequencies, (3) respond to various tasks and instructions and (4) attack the airfield. During half of the data collection sessions data input tasks were performed manually by the pilots using an upfront keypad; during the other half of the sessions, data input was accomplished by voice. Additional independent variables were: (1) auditory interference--number of communications requiring pilot response, and (2) workload -- maintain altitude, at either 300 feet or 10900 feet above ground level. Objective measures of performance for data input (speed and accuracy) and for aircraft control (deviations from command course airspeed and altitude) were collected while pilots navigated along the flight route. Objective measures collected during ground attack, included speed of target designation, total number of targets correctly designated, and stand-off distance from the airfield at target designation.

Author

*Aircraft Control; Attack Aircraft; Cockpit Simulators; Target Recognition; Weapons Delivery; Voice Control; Voice Data Processing*

1999009513 Institute of Aviation Medicine, Beijing, China

Two High Performance Fighter Pilots with Low +Gz Tolerance Rectified by Centrifuge Training

Geng, Xi-Chen, Institute of Aviation Medicine, China; Wang, Xuan, Institute of Aviation Medicine, China; Yan, Gui-Ding, Institute of Aviation Medicine, China; Chu, Xu, Institute of Aviation Medicine, China; Zhan, Chang-Lu, Institute of Aviation Medicine, China; Space Medicine and Medical Engineering; Feb. 1999; ISSN 1002-0837; Volume 12, No. 1, pp. 56-58; In Chinese

Report No.(s): CN-11-2774/R; No Copyright; Avail: CASI; A01, Hardcopy; A01, Microfiche

The objective of this study was to demonstrate the effects of training on rectifying two high performance fighter aircraft pilots with low +Gz tolerance. Anti-G straining maneuver (AGSM) and pressure breathing for +Gz (PBG) maneuver were trained during Centrifuge +Gz stress. After training, the +Gz tolerances with AGSM, and with PBG and anti-G suit were enhanced by 3.0 to about 3.25 G and 2.75 to about 3.0 G, respectively. The combined +Gz tolerance was higher than the relaxed +Gz tolerance by 4.25 to about 4.5 G. Both pilots had passed the 8 G 10 s SACM +Gz profile and reached the standard of training.

Author

Acceleration Tolerance; Aircraft Pilots; Human Centrifuges; Pressure Breathing; High Gravity Environments; Psychomotor Performance; Pilot Performance

19990102913 Institute for Human Factors TNO, Soesterberg, Netherlands

Mental Workload of the TACtical CO-ordinator of the Lynx Helicopter Final Report. *Mentale Werkbelasting van de TACtical CO-ordinator van de Lynx Helikopter*

Veltman, J. A., Institute for Human Factors TNO, Netherlands; Gaillard, A. W. K., Institute for Human Factors TNO, Netherlands; May 11, 1999; 29p; In Dutch

Contract(s)/Grants: TNO Proj. 788.2; A96/KM/327

Report No.(s): TD-99-0042, TNO-TM-99-A036; Copyright; Avail: Issuing Activity, Hardcopy

Within a few years the Lynx helicopter will be replaced probably by the NH90. Especially the TACtical CO-ordinator (TACCO) has to perform more tasks, while the present level of workload is already high. Therefore, it is important to have information about the causes of high workload. Furthermore, it is important to have reliable estimates of the workload in the future situation in order to take these into account in the choice of the future crew concept. The present study explores the factors that are related to the workload. Furthermore, the possibility to predict the workload in future systems, based upon number of tasks to be performed is explored. Five Lynx crews performed an anti submarine warfare (ASW) mission in the full mission Lynx simulator. The workload of the TACCO was measured objectively by means of the heart rate during the mission. The mission was recorded on video tape which was replayed after the mission. The crew members (pilot, TACCO and sensor operator) indicated the beginning and ending of each task and estimated the level of workload for each minute of the mission. The heart rate and subjective workload scores showed that the attack during the ASW mission was the most demanding segment of the mission. Future research on TACCO workload should be concentrated on this mission segment. Correlations between the number of tasks that were executed concurrently and the level of workload were low for the TACCO and the pilot, indicating that a prediction of workload based on the number of tasks is not reliable. The correlation was reasonably high for the sensor operator indicating that the prediction of workload based upon number of tasks is justified for the sensor operator. The situational awareness (SA) appeared to be a more important factor for the level of workload for the TACCO than the number of tasks. The workload will be acceptable as long as new information corresponds to his SA. However, when new information deviates from his SA or when information has a high level of uncertainty, the TACCO has to concentrate on this information, resulting in a high level of workload. To establish the workload of the TACCO in a future system, information about the easiness to build up SA is more important than the number of tasks to be performed.

Author

Workloads (Psychophysiology); Simulators; Mental Performance; Helicopters

## 15 MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

19990092815 Defence Evaluation Research Agency, Systems Integration Dept., Farnborough, UK

Int. gration of the Human Operator Into Complex Air Systems Using Alternative Control Technologies, I

Rood, G. M., Defence Evaluation Research Agency, UK; Sensor Data Fusion and Integration of the Human Element; February

1999, pp. 13-1 - 13-10; In English; See also 19990092805; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

In general, a combat aircraft can be described as a maneuverable airborne weapons platforms, which contain a series of electronic and other systems with which the aircraft is controlled, navigated, weapons selected, etc. and a series of systems which provide protection for the aircrew throughout the performance envelope of the aircraft and when emergency escape is unavoidable. Most aircraft platforms have an operation life of over 20 years - some a longer and in this timescale, although the basic platform does not significantly alter - mainly for costs reasons - the avionics and crew support systems fits can continue to advance a number of generation - which can allow the airframe to retain its operational competitiveness against newer designs. The speed and capacity of future avionic systems, themselves increasing in complexity, will result in the amount of information output heavily increased. This is often all fed to a single pilot who is flying the aircraft close to the ground at around 450 knots or more, perhaps in bad weather at night, and the flying process alone needs continuous monitoring. As the capabilities of aircraft will continue to increase through the use of more sophisticated, and a wider range of sensors, and control through software increases the ability to control the aircraft systems will inevitably require an even greater number of controls - many of these being necessary, at least in principle on the Hands On Throttle and Stick (HOTAS) controls, as many are time critical and need to operate eyes-out. The rise in the number of avionic systems and the consequent number of manual switching operation necessary during critical phases of operation has resulted in a gradual increase in the numbers of switches/controls per crew member in the cockpit. There are some indications from aircrew that the numbers of functions are becoming both difficult to remember - needing more training and sometimes difficult to operate with either standard aircrew gloves. What is required are alternative methods of inputting data to aircraft avionic systems, particularly if they provide a more natural and quicker interface. Of the more mature alternative control technologies, voice recognition and head tracking are both in operational flight and experimental flight depending upon the level of sophistication of the technology and are both technically mature enough for full operational use, with research on the next generation, higher capability systems in progress.

Derived from text

*Avionics; Cockpits; Complex Systems; Flight Crews; Pilot Support Systems; Aircraft Pilots; Control Equipment; Control Systems Design; Aircraft Control*

19990092816 Technische Univ., Inst. of Flight Guidance and Control, Brunswick, Germany

Fusion and Display of Data According to the Design Philosophy of Intuitive Use

Ardey, Goetz F., Technische Univ., Germany; Sensor Data Fusion and Integration of the Human Element; February 1999, pp. 14-1 - 14-7; In English; See also 19990092805; Copyright Waived; Avail: CASI; A02, Hardcopy; A03, Microfiche

Microelectronics, over a decade ago, have forced their way into military and airliner cockpits. On the military side, the physical contest prevailed; on the civilian side economic competition was the driver leading the evolution from the analog to the digital cockpit. In today state of the art military and civilian transportation aircraft, one can hardly find any information from a pilot's wish list, that is not provided by a sensor already installed. Despite this technical ability, there is still something wrong when according to the aviation accident statistics, human factors is often the ultimate reason for crashes. But this depends on the definition of 'Human factors'. It is well known, that even highly trained professional pilots abilities can easily be reduced to amateur status under excessive mental stress. In these situations the human mind only accepts intuitively perceived information as the basis for actions. Therefore it is vital, that new avionics with their inert tendency to become complex are carefully developed along the principles of intuitive use. This paper describes several parts of a project comprising the development of a new cockpit for general aviation aircraft. It focuses on aspects of the target group, design philosophy, and low costs.

Author

*Aircraft Accidents; Avionics; Cockpits; Human Factors Engineering; Microelectronics; Stress (Psychology); Aircraft Instruments; Pilot Support Systems*

19990094774 Naval Postgraduate School, Monterey, CA USA

Usability Evaluation of the Aviation Command Safety Assessment Web-Based Questionnaire

Williams, Thomas G.; Jun. 1999; 122p; In English

Report No.(s): AD-A366090; No Copyright; Avail: CASI; A06, Hardcopy; A02, Microfiche

Computer software has taken an increasingly larger role in the U.S. Navy. It is used in nearly every facet on naval operations, from administrative chores to controlling complex weapons systems. Because the high cost of software and the potential for inadvertent misuse, it is important that software be easy to use and understand. This thesis explores the methods and techniques available for conducting software usability evaluations. Using what described in this thesis, actual software usability testing is done on a recently developed Web site. The Web site [HTTP://SPITFIRE.AVSAFETY.NPS.NAVY.MIL](http://SPITFIRE.AVSAFETY.NPS.NAVY.MIL), evaluated in this study is designed to allow aviation units to complete a safety survey online. This thesis describes the usability test conducted on the Aviation Command Safety Assessment (ACSA) Web site and establishes a methodology that can be used on any future Navy Web

site. The results of this usability test show that improvement can be made to the interface design and presentation of Web site material.

DTIC

*Aircraft Safety; Software Engineering; Computer Programs; Flight Safety; Surveys*

19990087456 Arkansas Univ., Dept. of Engineering Technology, Little Rock, AR USA

Characterization of Test and Checkout Distributed Data Processing Systems

Ojha, Anand K., Arkansas Univ., USA; 1998 Research Reports: NASA/ASEE Summer Faculty Fellowship Program; March 1999, pp. 155-164; In English; See also 19990087441; No Copyright; Avail: CASI; A02, Hardcopy; A03, Microfiche

The need for test and checkout systems to ensure safety and reliability of aircraft and related systems for space missions cannot be overemphasized. A variety of systems, developed over several years, are in use at the NASA/KSC. Most of these systems are configured as distributed data processing systems. The existence of these heterogeneous systems motivated NASA/KSC to invent some mechanism or procedure to benchmark or evaluate the performance of these diverse systems. This paper first discusses various issues in performance evaluation of test and checkout systems. Next, it investigates four possible techniques to characterize test and checkout systems: (1) analytical method using queuing theory, (2) modeling and simulation software, (3) software emulation, and (4) monitoring tools. After discussing pros and cons of these techniques, it is determined that the monitoring tool technique would be the best choice in objectively characterizing test and checkout systems to obtain a better insight into their performance issues. Therefore, the paper finally concludes with two specific recommendations: (1) to explore the possibility of incorporating hybrid performance monitoring tools in the existing systems, and (2) to consider including such monitoring requirements while specifying new systems.

Author

*Distributed Processing; Heterogeneity; Performance Tests; Space Vehicle Checkout Program; Aircraft Maintenance; Checkout*

19990088096 Department of Defense, Office of Inspector General, Arlington, VA USA

Year 2000 Compliance of the Navy Pioneer Unmanned Aerial Vehicle

May 24, 1999; 14p; In English

Contract(s)/Grant(s): Proj. 9CC-0086-09

Report No.(s): AD-A366455; IG/DOD-99-169; No Copyright; Avail: CASI; A01, Microfiche; A03, Hardcopy

This is one in a series of reports being issued by the Inspector General, DoD, in accordance with an informal partnership with the Chief Information Officer, DoD, to monitor DoD efforts to address the year 2000 computing challenge. For a list of audit projects addressing the issue, see the year 2000 web page on the IGnet at <http://www.ignet.gov>. The overall audit objective was to assess the status of Military Department and Defense agency mission critical systems, identified by the U.S. Pacific Command and U.S. Forces Korea, as being of particular importance to them in attaining compliance with year 2000 conversion requirements. Specifically, we reviewed the progress of each system towards year 2000 compliance, testing and integration of modifications, and contingency plans. For this report, we reviewed the Navy Pioneer Unmanned Aerial Vehicle.

DTIC

*Pilotless Aircraft; Military Technology; Research*

19990101857 Indian Inst. of Tech., Kanpur, India

Two New Techniques for Aircraft Parameter Estimation using Neural Networks

Raisinghani, S. C., Indian Inst. of Tech., India; Ghosh, A. K., Indian Inst. of Tech., India; Kalra, P. K., Indian Inst. of Tech., India; The Aeronautical Journal; Jan. 1998; Volume 102, No. 1011, pp. 25-30; In English; See also 19990101884

Report No.(s): Paper 2349; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Two new techniques for estimating aircraft stability and control derivatives (parameters) from flight data using feed forward neural networks are proposed. Both techniques use motion variables and control inputs as the input file, while aerodynamic coefficients are presented as the output file for training a neural network. For the purpose of parameter estimation the trained neural network is presented with a suitably modified input file, and the corresponding predicted output file of aerodynamic coefficients is obtained. Suitable interpretation and manipulation of such input-output file yields the estimated values of the parameters. The methods are validated first on the simulated flight data and then on real flight data obtained by digitizing analog data from a published report. Results are presented to show how the accuracy of the estimates is affected by the topology of the network, the number of iterations and the intensity of the measurement noise in simulated flight data. One of the significant features of the

proposed method is that they do not require guessing of a reasonable set of starting values of the parameters as a popular parameter estimator like the maximum likelihood method does.

**Author**

*Aircraft Stability; Neural Nets; Aircraft Control; Control Equipment; Estimating; Feedforward Control; Flight Simulation*

## 16 PHYSICS

*Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.*

19990092372 Howard Univ., Dept. of Mechanical Engineering, Washington, DC USA

Investigation of the Relationship of Vortex-Generated Sound and Airframe Noise. *Final Report, 1 Mar. 1998 - 31 Oct. 1999*  
Smith, Sonya T., Howard Univ., USA; Nov. 20, 1998; 9p; In English

Contract(s)/Grant(s): NAG1-2015; No Copyright; Avail: CASI; A02, Hardcopy; A01, Microfiche

Airframe noise contributes the most to the environmental contamination from airports during take-off and landing. Two sources of noise are from the vortex-system associated with the slat and flap of multi-element wing designs. The flap-side edge vortex experiences bursting, known as vortex breakdown, at a critical deflection angle and experimental results show that this event may be one source of increased noise levels. Understanding of the edge roll-up phenomenon has increased but further focused studies on the role of the growth and bursting of the vortex structure are needed. The goal of the research is to plan a research program that will contribute to the understanding of the fluid physics of vortex breakdown and its relationship to noise production. The success of this program will lead to a priori predictions of when vortex breakdown will occur on the flap side-edge and accurate calculations of its effect on the noise level experienced by an observer near the aircraft during take-off and landing.

**Author**

*Actodynamic Noise; Airframes; Vortex Breakdown; Noise Intensity; Aircraft Noise*

19990094049 NASA Goddard Space Flight Center, Greenbelt, MD USA

Cryogenic Optical Performance of the Cassini Composite Infrared Spectrometer (CIRS) Flight Telescope  
Losch, Patricia, NASA Goddard Space Flight Center, USA; Lyons, James J., III, NASA Goddard Space Flight Center, USA; Hagopian, John, NASA Goddard Space Flight Center, USA; 1998; 1p; In English; Cryogenic Optical Systems and Instruments VIII, 19-24 Jul. 1998, San Diego, CA, USA; Copyright; Avail: Issuing Activity, Hardcopy; Abstract Only

The CIRS half-meter diameter beryllium flight telescope's optical performance was tested at the instrument operating temperature of 170 Kelvin. The telescope components were designed at Goddard Space Flight Center (GSFC) but fabricated out of house and then assembled, aligned and tested upon receipt at GSFC. A 24 inch aperture cryogenic test facility utilizing a 1024 x 1024 CCD array was developed at GSFC specifically for this test. The telescope's image quality (measured as encircled energy), boresight stability and focus stability were measured. The gold coated beryllium design exceeded the image performance requirement of 80% encircled energy within a 432 microns diameter circle.

**Author**

*Cryogenics; Optical Activity; Cassini Mission; Infrared Spectrometers; Telescopes; Flight Instruments; Performance Tests; Fabrication*

## 17 SOCIAL SCIENCES

*Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law; political science; and space policy; and urban technology and transportation.*

19990094487 North Dakota Univ., Grand Forks, ND USA

Developing a Model of Four-Year Aviation Program Quality: A Grounded Theory Approach  
Lindseth, Paul D., North Dakota Univ., USA; Collegiate Aviation Review; Sep. 1998, pp. 11-23; In English; See also 19990094485; No Copyright; Avail: CASI; A03, Hardcopy; A01, Microfiche

There has been a rapid increase in the number of four-year aviation programs in the U.S., from 20 programs in 1968 to over 70 programs today (UAA, 1994). The quality of these programs is difficult to determine since no research, other than accreditation standards, could be found concerning what criteria comprise a high quality four-year aviation program. Furthermore, having

aviation professionals prepared through quality academic programs seems essential for the safe operation of the U.S. air transportation industry. The purpose of this qualitative study was to identify criteria that support a definition or theory of quality within four-year aviation programs in the U.S. Using Glaser and Strauss (1967) grounded theory approach, data were collected from U.S. baccalaureate aviation program administrators and directors of training from U.S. major, national, and regional airlines. Eighty-two responses (63% response rate) were used in the analysis. Categories of criteria emerging from the study, such as curriculum, students, and faculty, were used to develop a model for four-year aviation program quality. Results of this study have implications for aviation program administrators and faculty for developing higher quality four-year aviation programs by placing more emphasis on identified criteria of program quality.

Author

*Airline Operations; Commercial Aircraft; Civil Aviation; Models; Management Planning*

**19**  
**GENERAL**

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Research Engineering *Annual Report, 1998*

Malcolm, Gerald N., Compiler, NASA Dryden Flight Research Center, USA; August 1999; 78p; In English

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Selected research and technology activities at Dryden Flight Research Center are summarized. These activities exemplify the Center's varied and productive research efforts.

Author

*Research and Development; Technology Utilization; Aerodynamics*

# Subject Term Index

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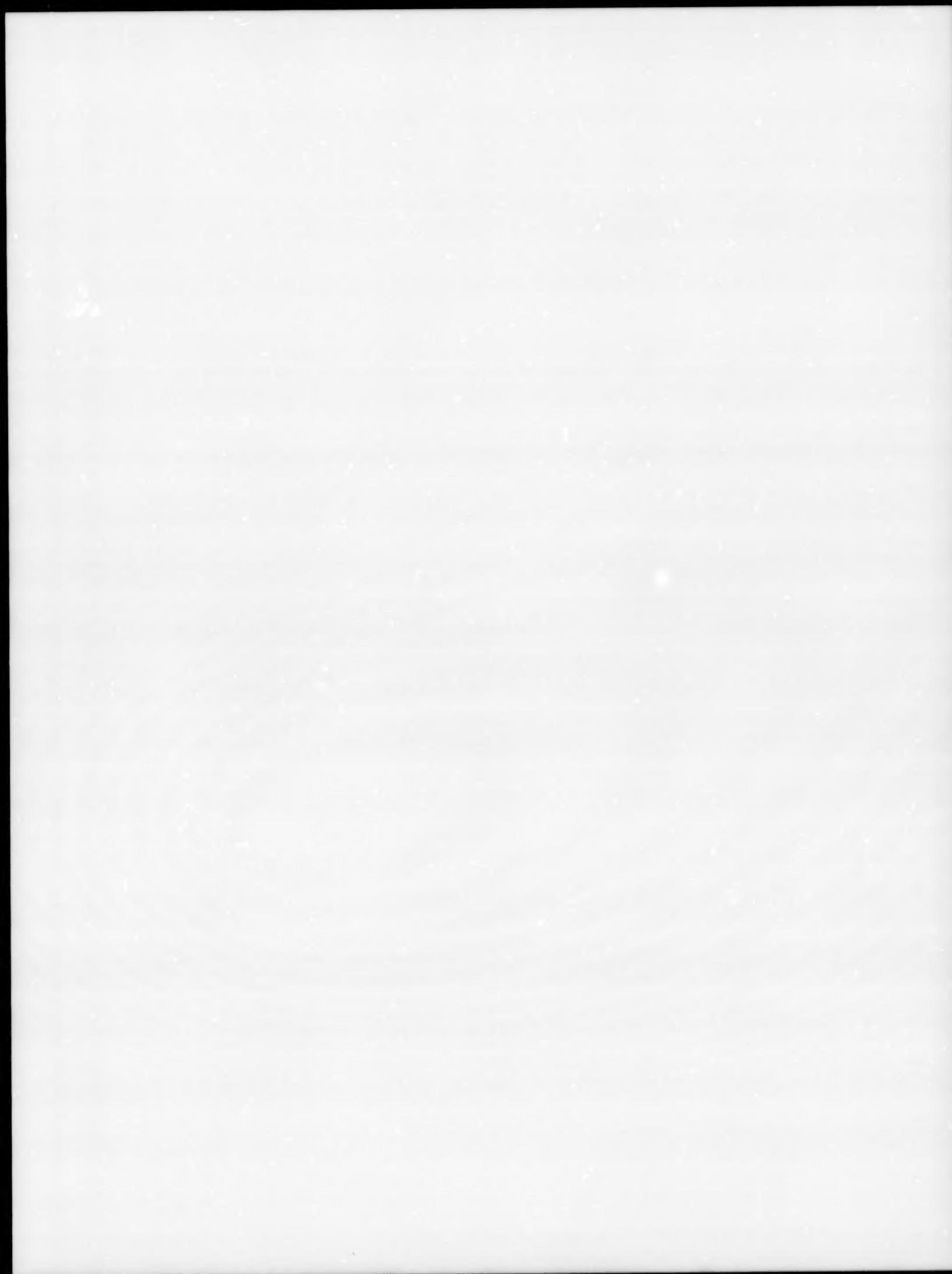
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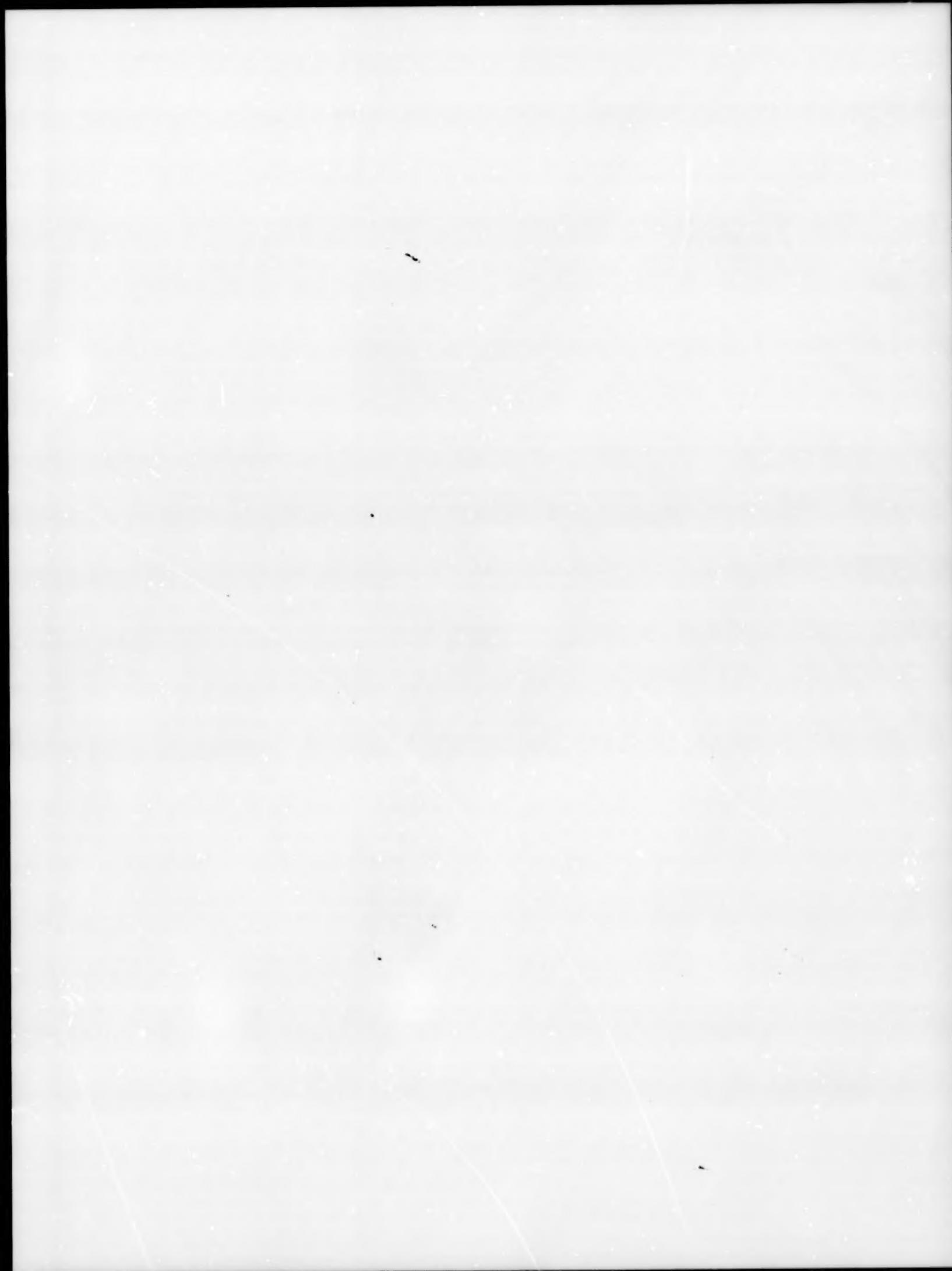
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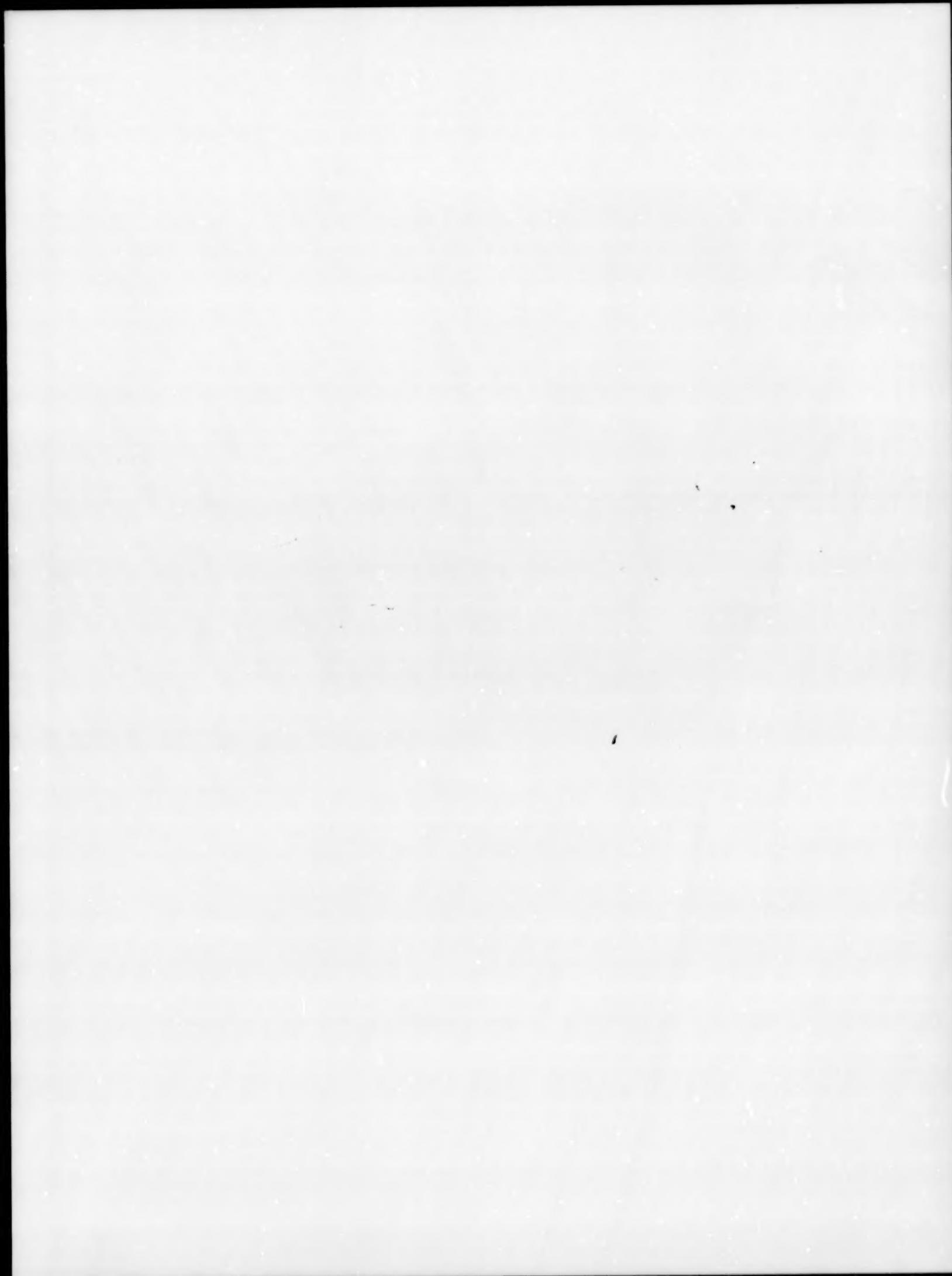
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